Appendix A

Characteristics of Chaff

This page intentionally left blank.

APPENDIX A CHARACTERISTICS OF CHAFF

Chaff is currently authorized for use in the existing Alaska training airspace and, under the Proposed Action, chaff would continue to be employed in the airspace. Chaff consists of extremely small strands (or dipoles) of an aluminum-coated crystalline silica core. When released from an aircraft, chaff initially forms a momentary electronic cloud and then disperses in the air and eventually drifts to the ground. The chaff effectively reflects radar signals in various bands (depending on the length of the chaff fibers) and forms an electronic image of reflected signals on a radar screen. Immediately after deploying chaff, the aircraft is obscured from radar detection by the cloud which momentarily breaks the radar lock. The aircraft can then safely maneuver or leave an area.

Chaff is made as small and light as possible so that it will remain in the air long enough to confuse enemy radar. Each chaff fiber is approximately 25.4 microns in diameter (thinner than a human hair) and ranges in length from 0.3 to over 1 inch. The weight of chaff material in the RR-170 or RR-188 cartridge is approximately 95 grams or 3.35 ounces (United States Air Force [Air Force] 1997). Since chaff can obstruct radar, its use is coordinated with the Federal Aviation Administration (FAA). RR-170-type combat chaff has been used by F-15C and F-15E training aircraft and similar chaff is used by F-22 aircraft currently training in Alaska airspace. This chaff is the same size and the cartridge is the same size as RR-188 chaff in Figure 1. RR-188 chaff has D and E band dipoles removed to avoid interference with FAA radar. RR-170 chaff dipoles are cut to disguise the aircraft and produce a more realistic training experience in threat avoidance.

A1 Chaff Composition

Chaff is comprised of silica, aluminum, and stearic acid, which are generally prevalent in the environment. Silica (silicon dioxide) belongs to the most common mineral group, silicate minerals. Silica is inert in the environment and does not present an environmental concern with respect to soil chemistry. Aluminum is the third most abundant element in the earth's crust, forming some of the most common minerals, such as feldspars, micas, and clays. Natural soil concentrations of aluminum ranging from 10,000 to 300,000 parts per million have been documented (Lindsay 1979). These levels vary depending on numerous environmental factors, including climate, parent rock materials from which the soils were formed, vegetation, and soil moisture alkalinity/acidity. The solubility of aluminum is greater in acidic and highly alkaline soils than in neutral pH conditions. Aluminum eventually oxidizes to Al_2O_3 (aluminum oxide) over time, depending on its size and form and the environmental conditions.

The chaff fibers have an anti-clumping agent (Neofat – 90 percent stearic acid and 10 percent palmitic acid) to assist with rapid dispersal of the fibers during deployment (Air Force 1997). Stearic acid is an animal fat that degrades when exposed to light and air.

A single bundle of chaff consists of the filaments in an 8-inch long rectangular tube or cartridge, a plastic piston, a cushioned spacer, and two plastic pieces, each 1/8-inch thick by 1-inch by 1-inch. The chaff dispenser remains in the aircraft. The plastic end caps and spacer fall to the ground when chaff is dispensed. Spacers are spongy material (felt) designed to absorb the force of release. Figure 1 illustrates the components of a chaff cartridge. Table 1 lists the components of the silica core and the aluminum coating. Table 2 presents the characteristics of RR-188 or RR-170 chaff.

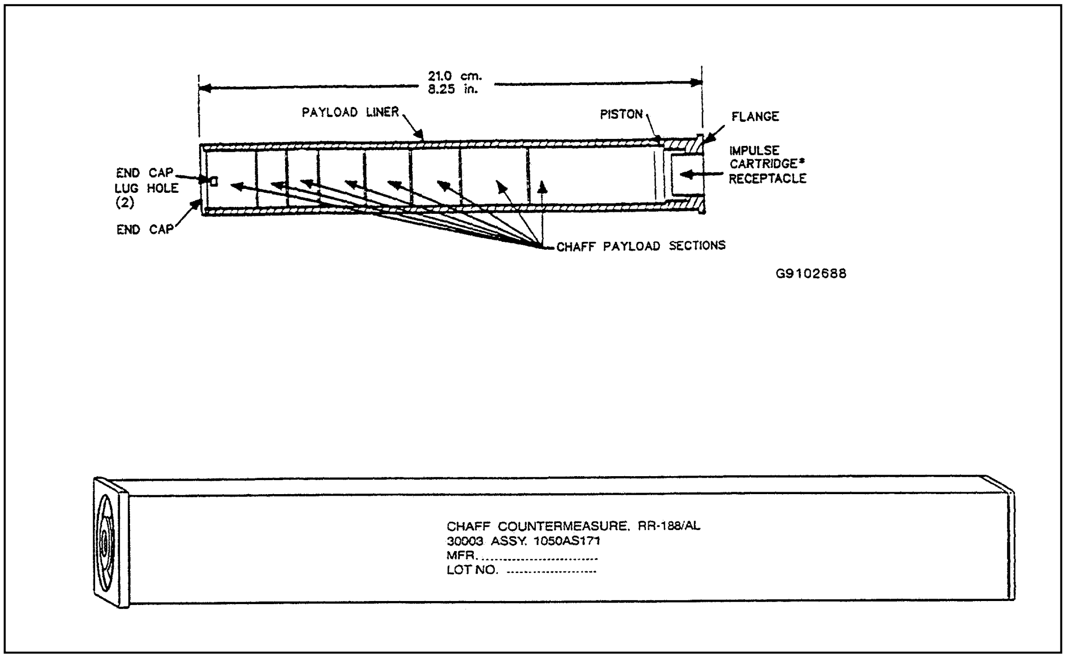


Figure 1. RR-188 or RR-170A/AL is a single cartridge containing 400,000 chaff dipoles, each in 8 cuts, a plastic end cap, piston, and felt pad.

Table 1. Components of RR-188 or RR-170 Chaff

Element	Chemical Symbol	Percent (by weight)
Silica Core		
Silicon dioxide	SiO_2	52-56
Alumina	Al_2O_3	12-16
Calcium Oxide and Magnesium Oxide	CaO and MgO	16-25
Boron Oxide	B_2O_3	8-13
Sodium Oxide and Potassium Oxide	Na_2O and K_2O	1-4
Iron Oxide	Fe_2O_3	1 or less
Aluminum Coating (Typically Alloy 1145)		
Aluminum	Al	99.45 minimum
Silicon and Iron	Si and Fe	0.55 maximum
Copper	Cu	0.05 maximum
Manganese	Mn	0.05 maximum
Magnesium	Mg	0.05 maximum
Zinc	Zn	0.05 maximum
Vanadium	V	0.05 maximum
Titanium	Ti	0.03 maximum
Others		0.03 maximum

Source: Air Force 1997

Table 2. Characteristics of RR-188 or RR-170 Chaff

Attribute	*RR-188*
Aircraft	F-15C, F-15E, F-22A
Composition	Aluminum coated silica
Ejection Mode	Pyrotechnic
Configuration	Rectangular tube cartridge
Size	8 x 1 x 1 inches (8 cubic inches)
Number of Dipoles	5.46 million
Dipole Size (cross-section)	1 mil (diameter)
Impulse Cartridge	BBU-35/B
Other Comments	Cartridge stays in aircraft; less interference with FAA radar (no D and E bands)

Source: Air Force 1997

RR-170 A/AL chaff is similar to RR-188 except that RR-170 A/AL is combat coded chaff to reflect tracking radar. RR-170 A/AL has approximately 400,000 dipoles, each in 8 cuts. Other than the cut of the dipoles, RR-170 A/AL chaff is essentially the same as RR-188 chaff in materials and cartridge design. A felt spacer, 1-inch x 1-inch x 1/8-inch end cap, a 1-inch x 1-inch x 1/4-inch piston, and the chaff dipoles are dispersed when the chaff bundle is deployed.

The F-22 uses the same chaff material in a slightly different chaff cartridge to expedite clean ejection of the chaff. The chaff cartridge design is less likely to leave debris of any kind in the dispenser bay yet still provides robust chaff dispensing. Figure 2 is a photograph of an F-22 chaff cartridge. The RR-180/AL for F-22 use has chaff packaged in soft packs that have a somewhat fewer number of dipoles per cut when compared with RR-170 chaff.

RR-180/AL chaff is similar to the RR-170 A/AL chaff cartridge with the primary exception that RR-180/AL chaff is contained in a dual chaff cartridge (see Figure 2). The dual chaff cartridge is a 1-inch x 1-inch x 8-inch cartridge with a plastic separator, or I-beam, dividing two hyperfine (0.7 millimeter diameter) chaff cartridges. The I-beam separator uses some space and the RR-180/AL chaff has approximately 340,000 dipoles each. Figure 2 presents the RR-180/AL chaff plastic cartridge, two pistons with attached felt spacers, and two end caps also with attached felt spacers, and the chaff dipoles before dispersion. Each of the two end caps and pistons is an approximately 1/2-inch x 1/4-inch x 1-inch plastic or nylon piece with attached felt spacer which falls to the surface when each chaff bundle is deployed. There are three parchment paper wrappers measuring approximately two inches by three inches in each of the dual chaff cartridge tubes. This parchment paper wrapping prevents the premature deployment of chaff too near the F-22 chaff distribution rack (Air Force 2008).

A2 Chaff Ejection

Chaff is ejected from aircraft pyrotechnically using a BBU-35/B impulse cartridge. Pyrotechnic ejection uses hot gases generated by an explosive impulse charge. The gases push the small piston down the chaff-filled tube. In the case of F-22 chaff, six paper pieces, two small plastic end cap, and two small plastic or nylon pistons are ejected along with the chaff fibers. The plastic tube remains within the aircraft. Residual materials from chaff deployment consist of four 2 by 3 inch pieces of paper, four ½ by 1 by 1/8 inch pieces of plastic or nylon, and the chaff. Table 3 lists the characteristics of BBU-35/B impulse cartridges used to pyrotechnically eject chaff.

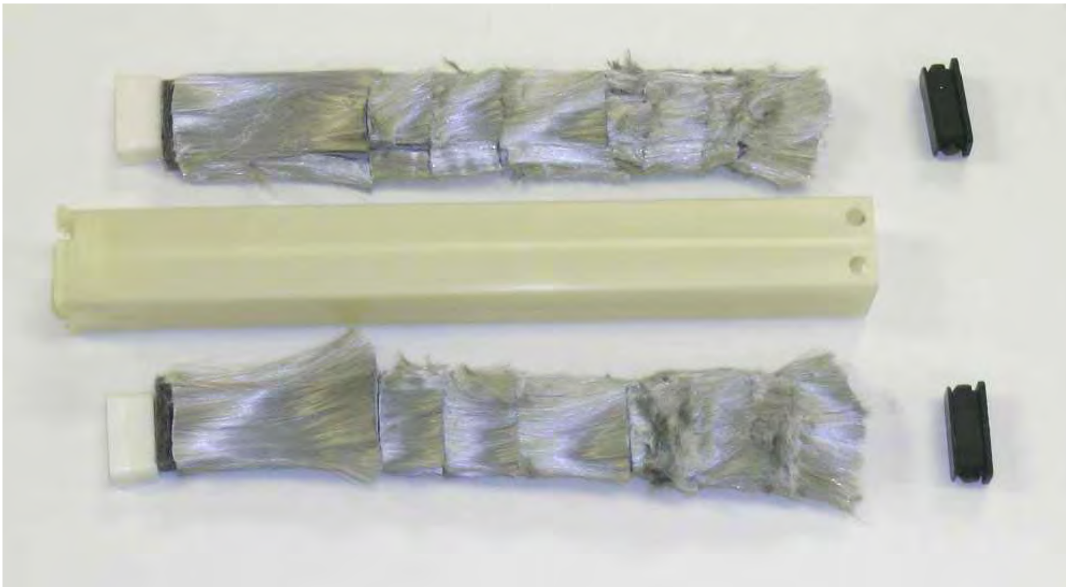


Figure 2. RR-180/AL chaff is a dual chaff cartridge with unconstrained hyperfine (.7 millimeter diameter) chaff, 340,000 dipoles per cut, in an I-beam reinforced cartridge.

Table 3. BBU-35/B Impulse Charges Used to Eject Chaff

Component	BBU-35/B
Overall Size Overall Volume Total Explosive Volume	0.625 inches x 0.530 inches 0.163 inches^3 0.034 inches^3
Bridgewire	Trophet A 0.0025 inches x 0.15 inches
Initiation Charge	0.008 cubic inches 130 mg 7,650 psi boron 20% potassium perchlorate 80% *
Booster Charge	0.008 cubic inches 105 mg 7030 psi boron 18% potassium nitrate 82%
Main Charge	0.017 cubic inches 250 mg loose fill RDX ** pellets 38.2% potassium perchlorate 30.5% boron 3.9% potassium nitrate 15.3% super floss 4.6% Viton A 7.6%

Source: Air Force 1997

Upon release from an aircraft, chaff forms a cloud approximately 30 meters in diameter in less than one second under normal conditions. Quality standards for chaff cartridges require that they demonstrate ejection of 98 percent of the chaff in undamaged condition, with a reliability of 95 percent at a 95 percent confidence level. They must also be able to withstand a variety of environmental conditions that might be encountered during storage, shipment, and operation.

Table 4 lists performance requirements for chaff. To achieve the performance standards and not be rejected, chaff is typically manufactured to a reliability of 99 percent or greater.

Table 4. Performance Requirements for Chaff

Condition	Performance Requirement	
High Temperature	Up to +165 degrees Fahrenheit	
Low Temperature	Down to –65 °F	
Temperature Shock	Shock from –70 °F to +165 °F	
Temperature Altitude	Combined temperature altitude conditions up to 70,000 feet	
Humidity	Up to 95 percent relative humidity	
Sand and Dust	Sand and dust encountered in desert regions subject to high sand dust conditions and blowing sand and dust particles	
Accelerations/Axis	G-Level	Time (minute)
Transverse-Left (X)	9.0	1
Transverse-Right (-X)	3.0	1
Transverse (Z)	4.5	1
Transverse (-Z)	13.5	1
Lateral-Aft (-Y)	6.0	1
Lateral-Forward (Y)	6.0	1
Shock (Transmit)	Shock encountered during aircraft flight	
Vibration	Vibration encountered during aircraft flight	
Free Fall Drop	Shock encountered during unpackaged item drop	
Vibration (Repetitive)	Vibration encountered during rough handling of packaged item	
Three Foot Drop	Shock encountered during rough handling of packaged item	

Note: Cartridge must be capable of total ejection of chaff from the cartridge liner under these conditions.

Source: Air Force 1997

A3 Policies and Regulations on Chaff Use

Current Air Force policy on use of chaff and flares was established by the Airspace Subgroup of Headquarter Air Force Flight Standards Agency in 1993. It requires units to obtain frequency clearance from the Air Force Frequency Management Center and the FAA prior to using chaff to ensure that training with chaff is conducted on a non-interference basis. This ensures electromagnetic compatibility between the FAA, the Federal Communications Commission, and

Department of Defense (DoD) agencies. The Air Force does not place any restrictions on the use of chaff provided those conditions are met (Air Force 1997).

Air Force Instruction (AFI) 13-201, U.S. Air Force Airspace Management, November 2007. This guidance establishes practices to decrease disturbance from flight operations that might cause adverse public reaction. It emphasizes the Air Force's responsibility to ensure that the public is protected to the maximum extent practicable from hazards and effects associated with flight operations.

AFI 11-214 Aircrew and Weapons Director and Terminal Attack Controller Procedures for Air Operations, December 2005. This instruction delineates procedures for chaff and flare use. It prohibits use unless in an approved area.

A4 References

Air Force. 1997. *Environmental Effects of Self-Protection Chaff and Flares*. Prepared for Headquarters Air Combat Command, Langley Air Force Base, Virginia.

_____. 1999. Description of the Proposed Action and Alternatives (DOPAA) for the Expansion of the Use of Self-Protection Chaff and Flares at the Utah Test and Training Range, Hill Air Force Base, Utah. Prepared for Headquarters Air Force Reserve Command Environmental Division, Robins AFB, Georgia.

_____. 2008. *Environmental Effects of Defensive Countermeasures: An Update*. Prepared for: Headquarters U.S. Air Forces Pacific Air Forces Command, Hickam AFB, Hawaii.

Appendix B

Characteristics and Analysis of Flares

APPENDIX B CHARACTERISTICS AND ANALYSIS OF FLARES

B1 Introduction

The F-22 uses MJU-10/B self-protection flares in approved airspace over parts of Alaska. The F-15E and F-15C historically deployed MJU-7 A/B and MJU-10/B self-protection flares The Self-protection flares are magnesium pellets that, when ignited, burn for 3.5 to 5 seconds at 2,000 degrees Fahrenheit. The burn temperature is hotter than the exhaust of an aircraft, and therefore attracts and decoys heat-seeking weapons targeted on the aircraft. Flares are used in pilot training to develop the near instinctive reactions to a threat that are critical to combat survival. This appendix describes flare composition, ejection, risks, and associated regulations.

B2 Flare Composition

Self-protection flares are primarily mixtures of magnesium and Teflon (polytetrafluoroethylene) molded into rectangular shapes (United States Air Force [Air Force] 1997). Longitudinal grooves provide space for materials that aid in ignition such as:

- First fire materials: potassium perchlorate, boron powder, magnesium powder, barium chromate, Viton A, or Fluorel binder.
- Immediate fire materials: magnesium powder, Teflon, Viton A, or Fluorel
- Dip coat: magnesium powder, Teflon, Viton A or Fluorel

Typically, flares are wrapped with an aluminum-coated mylar or filament-reinforced tape (wrapping) and inserted into an aluminum (0.03 inches thick) case that is closed with a felt spacer and a small plastic end cap (Air Force 1997). The top of the case has a pyrotechnic impulse cartridge that is activated electrically to produce hot gases that push a piston, the flare material, and the end cap out of the aircraft into the airstream. Table 1 provides a description of MJU-10/B and MJU-7 A/B flare components. Typical flare composition and debris are summarized in Table 2. Figure 1 is an illustration of an MJU-10/B flare, Figure 2 an illustration of an MJU-7 A/B flare. The MJU-7 (T-1) flare simulator is the same size as described for the MJU-7 A/B flare.

Table 1. Description of MJU-10/B and MJU-7 A/B Flares

Attribute	*MJU-10/B*	*MJU-7 A/B*
Aircraft	F-15, F-22	F-15
Mode	Semi-Parasitic	Semi-Parasitic
Configuration	Rectangle	Rectangle
Size	2 x 2 x 8 inches (32 cubic inches)	1 x 2 x 8 inches (16 cubic inches)

Attribute	*MJU-10/B*	*MJU-7 A/B*
Impulse Cartridge	BBU-36/B	BBU-36/B
Safe and Initiation Device (S&I)	Slider Assembly	Slider Assembly
Weight (nominal)	40 ounces	13 ounces

Table 2. Typical Composition of MJU-10/B and MJU-7 A/B Self-Protection Flares

Part	*Components*
Combustible	
Flare Pellet	Polytetrafluoroethylene (Teflon) (-$[C_2F_4]_n$ – n=20,000 units) Magnesium (Mg) Fluoroelastomer (Viton, Fluorel, Hytemp)
First Fire Mixture	Boron (B) Magnesium (Mg) Potassium perchlorate ($KClO_4$) Barium chromate ($BaCrO_4$) Fluoroelastomer
Immediate Fire/ Dip Coat	Polytetrafluoroethylene (Teflon) (-$[C_2F_4]_n$ – n=20,000 units) Magnesium (Mg) Fluoroelastomer
Assemblage (Residual Components)	
Aluminum Wrap	Mylar or filament tape bonded to aluminum tape
End Cap	Plastic (nylon)
Felt Spacers	Felt pads (0.25 inches by cross section of flare)
Safe & Initiation (S&I) Device (MJU-7 A/B only)	Plastic (nylon, tefzel, zytel)
Piston	Plastic (nylon, tefzel, zytel)

Source: Air Force 1997

3.0 Flare Ejection

The MJU-10/B and the MJU-7 A/B are semi-parasitic type flares that use a BBU-36/B impulse cartridge. In these flares, a slider assembly incorporates an initiation pellet (640 milligrams of magnesium, Teflon, and Viton A or Fluorel binder). This pellet is ignited by the impulse cartridge, and hot gases reach the flare as the slider exits the case, exposing a fire passage from the initiation pellet to the first fire mixture on top of the flare pellet. Table 3 describes the components of BBU-36/B impulse charges.

Flares are tested to ensure they meet performance requirements in terms of ejection, ignition, and effective radiant intensity. If the number of failures exceeds the upper control quality assurance acceptance level, the flares are returned to the manufacturer. A statistical sample is taken to ensure that approximately 99 percent must be judged reliable for ejection, ignition, and intensity.

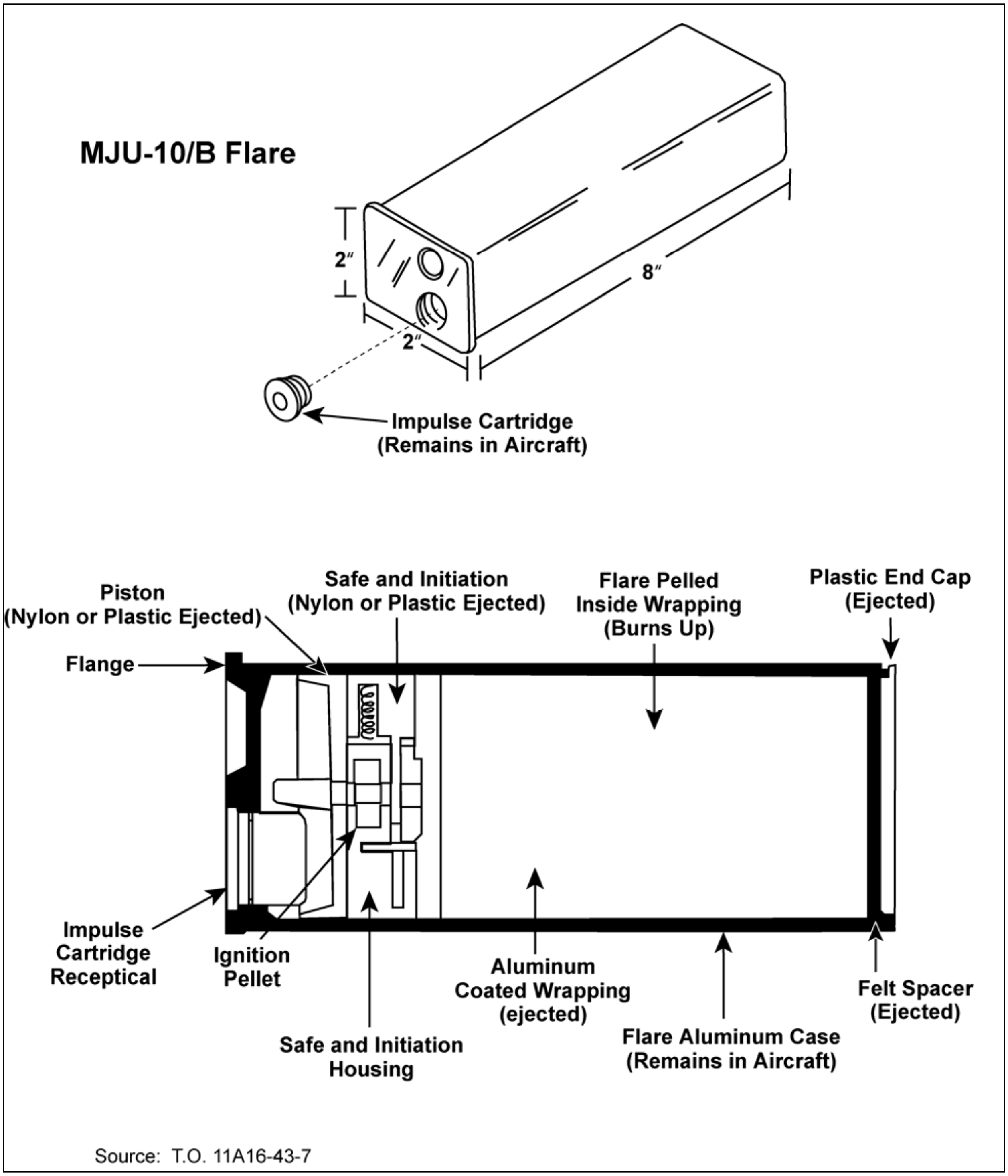


Figure 1. MJU-10/B Flare

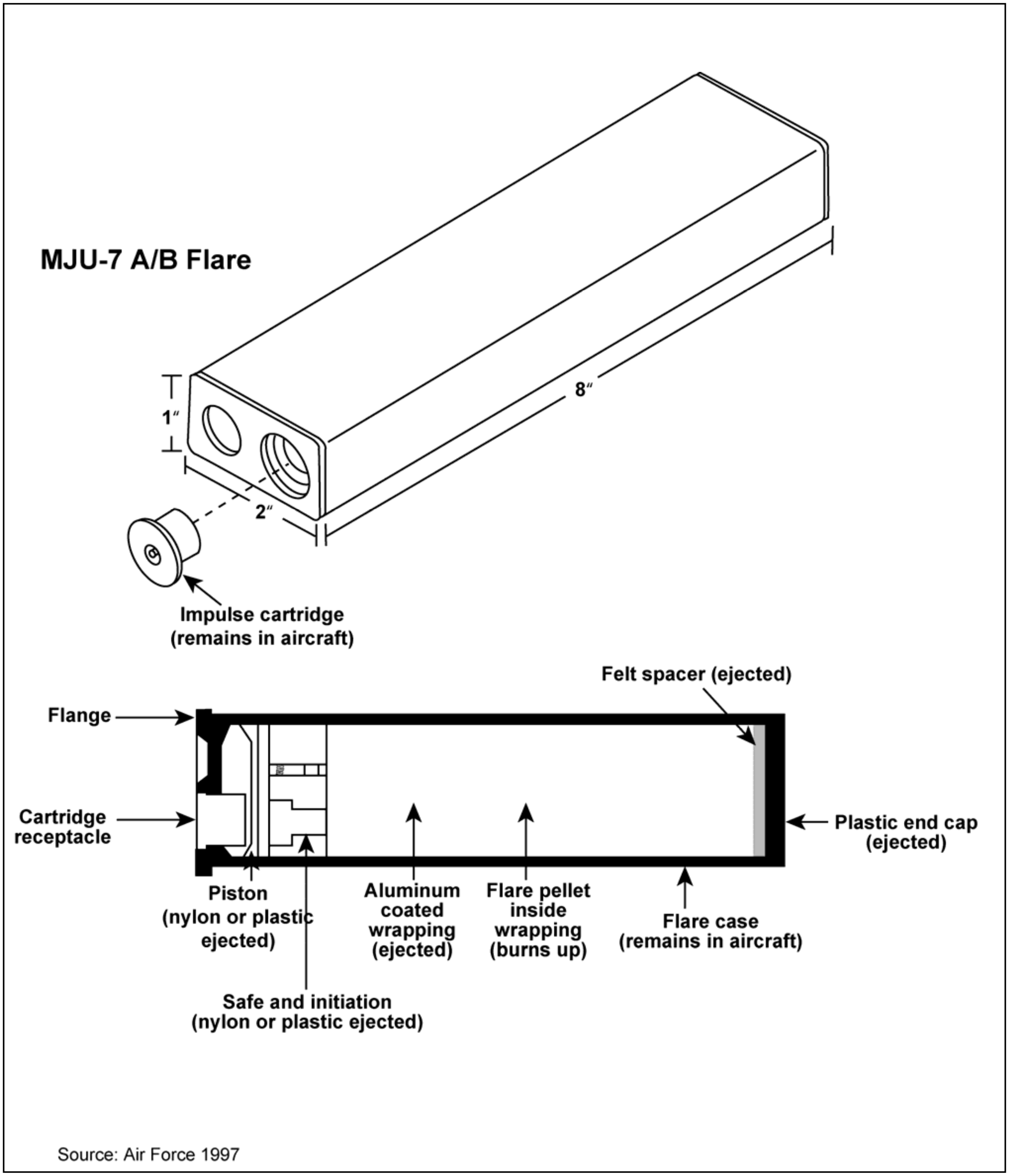


Figure 2. MJU-7 A/B Flare

Flare failure would occur if the flare failed to eject, did not burn properly, or failed to ignite upon ejection. For training use within the airspace, a dud flare would be one that successfully ejected but failed to ignite. That probability is projected to be 0.01 percent based upon dud flares located during military range cleanup.

B4 Risks Associated with Flare Use

Risks associated with the use of flares fall within two main categories: the risk of fire from a flare and the risk of being struck by a residual flare component.

B4.1 Fire Risk

Fire risk associated with flares stems from an unlikely, but possible scenario which results in the flare reaching the ground or vegetation while still burning. The altitude from which flares are dropped is strictly regulated by the airspace manager, and is based on a number of factors including flare burn-out rate. The flare burn-out rate is shown in Table 4. Defensive flares typically burn out in 3.5 to 5 seconds, during which time the flare will have fallen between 200 and 400 feet. Specific defensive flare burn-out rates are classified. Table 4 is based on conditions that assume zero aerodynamic drag and a constant acceleration rate of 32.2 feet per second per second.

$D = (V_o * T) + (0.5 * (A * T^2))$

Where:

D = Distance

Vo = Initial Velocity = 0

T = Time (in Seconds)

A = Acceleration

Table 3. Components of BBU-36/B Impulse Charges

Component	*BBU-36/B*
Overall Size Overall Volume Total Explosive Volume	0.740 x 0.550 inches 0.236 cubic inches 0.081 cubic inches
Bridgewire	Trophet A
Closure Disk	Scribed disc, washer

Component	*BBU-36/B*
	Initiation Charge
Volume	0.01 cubic inches
Weight	100 mg
Compaction	6,200 psi
Composition	42.5% boron 52.5 % potassium perchlorate 5.0% Viton A
	Booster Charge
Volume	0.01 cubic inches
Weight	150 mg
Compaction	5,100 psi
Composition	20% boron 80% potassium nitrate
	Main Charge
Volume	0.061 cubic inches
Weight	655 mg
Compaction	Loose fill
Composition	Hercules #2400 smokeless powder (50-77% nitrocellulose, 15-43% nitroglycerine)

Source: Air Force 1997

Table 4. Flare Burn-out Rates

Time (in Sec)	*Acceleration*	*Distance (in feet)*
0.5	32.2	4.025
1.0	32.2	16.100
1.5	32.2	36.225
2.0	32.2	64.400
2.5	32.2	100.625
3.0	32.2	144.900
3.5	32.2	197.225
4.0	32.2	257.600
4.5	32.2	326.025
5.0	32.2	402.500
5.5	32.2	487.025
6.0	32.2	579.600
6.5	32.2	680.225
7.0	32.2	788.900
7.5	32.2	905.625
8.0	32.2	1030.400
8.5	32.2	1163.225
9.0	32.2	1304.100
9.5	32.2	1453.025
10.0	32.2	1610.000

Note: Initial velocity is assumed to be zero.

4.2 Flare Strike Risk

Residual flare materials are those that are not completely consumed during ignition and fall to the ground, creating the risk of striking a person or property. Residual material from the MJU-10/B and the MJU-7 A/B consists of an end cap, an initiation assembly (safe and initiation device [S&I]), a piston, one or two felt spacers, and an aluminum-coated mylar wrapper (Table 5). For both flare types, the wrapper may be partially consumed during ignition, so the wrapping residual material could range in size from the smallest size, 1 inch by 1 inch, to the largest size, 4 inches by 13 inches. The size of the residual wrapping material would depend upon the amount of combustion that occurred as the flare was deployed.

Table 5. Residual Material from MJU-10/B and MJU-7 A/B Flares

Component	*Weight*
MJU-10/B	
End cap	0.0144 pounds
Safe & Initiation (S&I) device	0.0453 pounds
Piston	0.0144 pounds
Felt spacer	0.0025 pounds
Wrapper (4 inches x 13 inches)	0.0430 pounds
MJU-7 A/B	
End cap	0.0072 pounds
Safe & Initiation (S&I) device	0.0453 pounds
Piston	0.0072 pounds
Felt spacer	0.0011 pounds
Wrapper (3 inches x 13 inches)	0.0322 pounds

After ignition, as described in section 3.0, most residual components of the MJU-10/B and the MJU-7 A/B flare have high surface to mass ratios and are not judged capable of damage or injury when they impact the surface. One component of the MJU-10/B and the MJU-7 A/B flare, referred to as the S&I device, has a weight of approximately 0.725 ounces (0.0453 pounds). It is sized and shaped such that it is capable of achieving a terminal velocity that could cause injury if it struck a person.

The following discussion addresses the likelihood of an S&I device striking a person and the effect if such a strike were to occur.

B4.2.1 Technical Approach

Joint Base Elmendorf-Richardson (JBER) aircraft training flights are distributed randomly and uniformly within the Military Operations Areas (MOAs). Avoidance areas that are designated for low altitude flight need not be avoided for higher altitude flight. Flare component release altitudes and angles of release are sufficiently random that ground impact locations of flare materials are also assumed to be uniformly distributed under the MOAs.

For any particular residual component of a released flare, the conditional probability that it strikes a particular object is equal to the ratio of the object area to the total area of the MOA. For multiple objects (i.e., people, structures, vehicles), the probability of striking any one object is the ratio of the sum of object areas to the MOA. The frequency of a residual component striking one of many objects is the frequency of releasing residual components times the conditional probability of striking one of the many objects per given release.

In equation form, this relationship is:

$$Strike\ frequency = component\ drop\ frequency\ in\ MOA \times \frac{area\ of\ object \times number\ of\ objects\ in\ MOA}{MOA(area)}$$

The potential consequences of a residual component with high velocity and momentum striking particular objects are postulated as follows:

Striking the head of an unprotected individual: possible concussion

Striking the body of an unprotected individual: possible injury

Striking a private structure: possible damage

Striking a private vehicle: possible damage (potential injury if vehicle moving)

The effect of the impact of a residual MJU-7 A/B or MJU-10/B component from Table 6 is judged by computing the component's terminal velocity and momentum.

Terminal velocity (V_T) is calculated by the equation:

$$V_T = \left[\frac{2}{\rho}\left(\frac{W}{A \times C_d}\right)\right]^{0.5} = 29 \times \left(\frac{W}{A}\right)^{0.5}$$

Where: V_T = Terminal Velocity (in Feet/Second)
ρ = Nominal Air Density (2.378×10^{-3} lbs-sec^2/feet^4)
W = Weight (in Pounds)
A = Surface Area Facing the Air stream (in feet^2)
C_d = Drag Coefficient = 1.0

Drag coefficients are approximately 1.0 over a wide range of velocities and Reynolds numbers (Re) for irregular objects (e.g., non-spherical). Using this drag coefficient, the computed terminal velocities (Table 7) produce Re values within this range ($Re < 2 \times 10^5$), which justifies the use of the drag coefficient.

The weights and geometries of major flare components are approximately as listed in Table 6.

Terminal velocity momentums of these components are computed based on maximum (two square inches) and minimum (one square inch) areas and are listed in Table 7. Actual values would be between these extremes. The momentum values are the product of mass (in slugs) and velocity. A slug is defined as the mass that, when acted upon by a 1-pound force, is given an acceleration of 1.0 feet/sec^2.

Table 6. MJU-10/B and MJU-7 A/B Flare Major Component Properties

Component	*Geometry*	*Dimensions (inches)*	*Weight (Pounds)*
MJU-10/B			
S&I device	Rectangular solid	2 x 0.825 x 0.5	0.0453
Piston	Rectangular open	2 × 2 × 0.25	0.0144
End Caps	Rectangular plate	2 × 2 × 0.125	0.0144
MJU-7 A/B			
S&I device	Rectangular solid	2 × 0.825 × 0.5	0.0453
Piston	Rectangular open	2 × 0.825 × 0.5	0.0072
End Caps	Rectangular plate	1 × 2 × 0.125	0.0072

Table 7. MJU-10/B and MJU-7 A/B Flare Component Hazard Assessment

	Maximum Surface Area			*Minimum Surface Area*		
Component	*Area (in^2)*	*Terminal Velocity (ft/sec)*	*Momentum (lb-sec)*	*Area (in^2)*	*Terminal Velocity (ft/sec)*	*Momentum (lb-sec)*
MJU-10/B						
S&I device	1.65	58	0.08	0.41	115	0.16
Piston	4.0	21	0.009	0.50	59	0.03
End Cap	4.0	21	0.009	0.25	84	0.04
MJU-7 A/B						
S&I device	1.65	58	0.08	0.41	115	0.16
Piston	1.65	23	0.005	0.41	46	0.01
End Caps	2.0	21	0.005	0.13	84	0.02

The focus of this analysis will be the S&I device. Other flare components are not calculated to achieve a momentum that could cause damage.

The maximum momentum of the S&I device would vary between 0.08 and 0.16 pound-seconds depending upon orientation. In this momentum range, an injury is postulated that could be equivalent to a bruise from a large hailstone. Approximately 20 percent of any strikes could be to the head. A potentially more serious injury could be expected if the head were struck.

As a basis of comparison, laboratory experimentation in accident pathology indicates that there is a 90 percent probability that brain concussions would result from an impulse of 0.70 pound-seconds to the head, and less than a 1 percent probability from impulses less than 0.10 pound-seconds (Air Force 1997). The only MJU-7 A/B or MJU-10/B component with momentum values near 0.10 pound-seconds is the S&I device with a momentum between 0.08 and 0.16 pound-seconds. A strike of an S&I device to the head has approximately a 1 percent probability of causing a concussion.

What would be the likelihood of a hailstone sized S&I device striking an individual? People at risk of being struck by a dropped S&I device are assumed to be standing outdoors under a MOA (people in structures or vehicles are assumed protected). The dimensions of an average person are approximately 5 feet 6 inches high by 2 feet wide by 1 foot deep (men 5 feet 10 inches; women 5 feet 4 inches; children varied). The S&I device is expected to strike ground objects at an angle of 80 degrees or greater to the ground, assuming 80 degrees to the ground allows for possible wind or other drift effects. With the flare component falling at 80 degrees to the ground, a person's body (5.5 × 2 × 1 feet) projects an area of 3.9 $feet^2$ normal to the path of the dropped component. In a normal case, a person would be outdoors and unprotected 10 percent of the time based on Department of Energy and Environmental Protection Agency national studies (Tennessee Valley Authority 2003; Klepeis et al. 2001). In the case of hunting or fishing, a person is assumed to be out of doors and unprotected 2/3 of the day (although a person would probably be wearing a hat or other head covering during such activity).

The frequencies of a strike to an unprotected person can be computed based on the data and assumptions presented above. Flight maneuvers to deploy flares are assumed to be randomly distributed throughout the training airspace.

A personnel injury could occur if an S&I device struck an unprotected person. The frequency of striking a person is:

$$Injury\ frequency = comp\,drop\ freq \times \frac{body\,area \times pop.density \times Fract\,unprot \times MOA(area)}{MOA(area)}$$

Under the Stony MOAs, this calculates to approximately:

$$Injury\ frequency = 10{,}000 / year \times 3.9\ ft^2 / pers \times 0.1\, pers / mi^2 \times 0.67 \times 3.59 \times 10^{-8}\ mi^2 / ft^2$$
= 0.00009 injuries/year

This means that in a representative Alaskan rural area beneath a MOA used extensively for pilot training (see Table 2.2-4), the annual expected person strike frequency would be less than one person in every 10,000 years.

The maximum momentum of the S&I device, either from an MJU-7 A/B or an MJU-10/B flare, would vary between 0.08 and 0.16 pound-seconds depending upon orientation of the falling S&I device. In this momentum range, an injury is postulated that could be equivalent to a bruise from a large hailstone. Approximately 20 percent of any strikes could be to the head.

As a basis of comparison, laboratory experimentation in accident pathology indicates that there is a less than a 1 percent probability of a brain concussion from an impulse of less than 0.10 pound-seconds to the head, and a 90 percent probability that brain concussions would result from an impulse of 0.70 pound-seconds to the head (Air Force 1997). The only MJU-7 A/B or MJU-10/B component with momentum values near 0.10 pound-seconds is the S&I device with a momentum between 0.08 and 0.16 pound-seconds. A strike of an S&I device to the head has approximately a 1 percent probability of causing a concussion.

This means that there would be an approximately 1 in 100 chance of a concussion in 10,000 years of flare use over the Stony MOAs. This level of risk is negligible.

The S&I device maximum momentum would vary between 0.08 and 0.16 pound-seconds depending upon orientation. A strike to a vehicle could cause a cosmetic dent similar to a hailstone impact. Although not numerically estimated, a strike to a moving vehicle could result in a vehicle accident.

B5 Policies and Regulations Addressing Flare Use

Air Force policy on flare use was established by the Airspace Subgroup of Headquarters Air Force Flight Standards Agency in 1993 (Memorandum from John R. Williams, 28 June 1993) (Air Force 1997). This policy permits flare drops over military-owned or controlled land and in Warning Areas. Flare drops are permitted in MOAs and Military Training Routes (MTRs) only when an environmental analysis has been completed. Minimum altitudes must be adhered to. Flare drops must also comply with established written range regulations and procedures.

Air Force Instruction (AFI) 11-214 prohibits using flare systems except in approved areas with intent to dispense, and sets certain conditions for employment of flares. Flares are authorized over government-owned and controlled property and over-water Warning Areas with no minimum altitude restrictions when there is no fire hazard. If a fire hazard exists, minimum altitudes will be maintained in accordance with the applicable directive or range order. An Air Combat Command supplement to AFI 11-214 (15 October 2003) prescribes a minimum flare employment altitude of 2,000 feet above ground level (AGL) over non-government owned or controlled property (Air Force 1997).

JBER has a more stringent policy regarding flare use than that outlined in AFI 11-214. Within JBER airspaces approved for flare use, flares may only be deployed above 5,000 feet AGL from June 1 through September 30. For the remainder of the year, the minimum altitude for flare use is 2,000 feet AGL.

B6 References

Klepeis, Neil E., William C. Nelson, Wayne R. Ott, John P. Robinson, Andy M. Tsang, Paul Switzer, Joeseph V. Behar, Stephen C. Hern, and William H. Engelmann. The National Human Activity Pattern Survey (NHAPS) a resource for assessing exposure to environmental pollutants. http://exposurescience.org/research.shtml#NHAPS

Science Applications International Corporation. 2006. Draft Environmental Effects of Defensive Countermeasures: An Update. Prepared for U.S. Air Force Air Combat Command.

Tennessee Valley Authority. 2003. On the Air, Technical Notes on Important Air Quality Issues, Outdoor Ozone Monitors Over-Estimate Actual Human Ozone Exposure. http://www.tva.gov/environment/air/ontheair/pdf/outdoor.pdf

United States Air Force (Air Force). 1997. Environmental Effects of Self Protection Chaff and Flares. Final Report. August.

United States Bureau of the Census. 2000. Table DP-1 Profile of General Demographic Characteristics. Census 2000 SF-1. Available on-line at http://factfinder.census.gov.

Appendix C

Public and Agency Outreach

This page intentionally left blank.

DEPARTMENT OF THE AIR FORCE
PACIFIC AIR FORCES

MEMORANDUM FOR SEE DISTRIBUTION

18 Nov 2010

FROM: 673 CES/CC
6326 Arctic Warrior Drive
Joint Base Elmendorf-Richardson AK 99506-3240

SUBJECT: F-22 Plus-Up Environmental Assessment

1. The United States Air Force (Air Force) is preparing an F-22 Plus-Up Environmental Assessment (EA) to evaluate the potential environmental consequences of a proposal to add seven F-22 aircraft to the Joint Base Elmendorf-Richardson (JBER) inventory. The proposed action would replace F-15 aircraft which were relocated from JBER in September 2010. Under the F-22 Beddown Environmental Assessment completed in 2006, two of the three JBER-based F-15 squadrons left JBER and two F-22 squadrons arrived. Subsequently, the third F-15 squadron was reassigned from JBER. This Plus-Up EA will address two alternatives: the proposed addition of seven F-22 aircraft to the existing F-22 squadrons and the No Action alternative. The Proposed Action under consideration would not require expansion of existing airspace or construction of any new facilities.

2. The Air Force will publish a notice of EA preparation in the Anchorage Daily News, the Mat-Su Valley Frontiersman, and the Eagle River Star.

3. In an effort to analyze the potential effects of this Proposed Action, the Air Force or its contractor, SAIC, may be contacting you in their data collection efforts. Please provide your comments or information to the proposed EA not later than 6 January 2011 in order to be incorporated in the preparation of the draft EA. In advance, we thank you for your assistance in this activity.

4. If you have any specific questions about the proposal, we would like to hear from you. Please feel free to contact Ms. Ellen Godden at the above address or at (907) 552-7483. General questions may be directed to Mr. Bob Hall at (907) 552-8152. Thank you for your assistance in this matter.

J. DAVID NORTON, Lt Col, USAF
Commander

Attachment:
Distribution List

F-22 Plus-Up Environmental Assessment
Joint Base Elmendorf-Richardson, Alaska
Agency Coordination
EA Memorandum Distribution List

Federal Aviation Administration, Alaska Region
ATTN: Bob Lewis
222 West 7th Ave. #14
Anchorage, AK 99513

U.S. Department of Agriculture
ATTN: Robert Jones
Natural Resources Conservation Service
800 W. Evergreen Ave., Suite 100
Palmer, AK 99545-6539

U.S. Department of Interior
ATTN: Pamela Bergmann
Office of Environmental Policy
1689 C Street, Rm. 119
Anchorage, AK 99501

U.S. Department of Transportation
ATTN: David Miller
Federal Highway Administration
P.O. Box 21648
Juneau, AK 99802-1648

U.S. Department of Transportation
ATTN: Robert Bouchard
Maritime Administration
1200 New Jersey Ave., SE (mar-510,#w21-224
Washington, DC 20590

U.S. Department of Interior
ATTN: Edward Parisian
Bureau of Indian Affairs, Alaska Regional Office
P.O. Box 25520
Juneau, AK 99802

U.S. Department of Transportation
ATTN: Richard Krochalis
Federal Transit Administration, Regional 10
915 Second Ave., Ste. 3142
Seattle, WA 98174-1002

U.S. Fish and Wildlife Service
ATTN: Ann Rappoport
Anchorage Fish & Wildlife Field Office
605 4th Ave., Rm. G-61
Anchorage, AK 99501

United States Coast Guard
ATTN: CAPT Jason Fosdick
Sector Anchorage
510 L Street, Ste. 100
Anchorage, AK 99501

National Marine Fisheries Service
ATTN: Brad Smith
Protected Resources Div/Habitat Consrv
222 W. 7th Avenue, Rm. 517
Anchorage, AK 99513

National Park Service
ATTN: Sue Masica
Alaska Regional Office
240 W 5th Avenue, Room 114
Anchorage, AK 99501

Bureau of Land Management
ATTN: Gary Reimer
Anchorage District Office
4700 BLM Rd.
Anchorage, AK 99507

U.S. Environmental Protection Agency, Region 10
ATTN: Jacques Gusmano
222 West 7th Ave.
Room 537
Anchorage, AK 99513-7588

Alaska Department of Environmental Conservation
ATTN: Deb Caillouet
555 Cordova
Anchorage, AK 99501

Alaska Department of Fish and Game
ATTN: Mark Burch
Division of Wildlife Conservation
333 Raspberry Rd.
Anchorage, AK 99518-1599

Alaska Department of Military and Veterans Affairs
ATTN: MAJ GEN Thomas Katkus
PO Box 5800
Camp Denali
JBER, AK 99505

Alaska Department of Natural Resources
ATTN: Thomas Irwin
Office of the Commissioner
550 W. 7th Avenue, Suite 1400
Anchorage, AK 99501

Alaska Department of Natural Resources
ATTN: Judith Bittner
Office of History and Archaeology

550 W 7th Avenue, Ste. 1310
Anchorage, AK 99501

Alaska Department of Natural Resources
ATTN: James King
Parks and Outdoor Recreation
550 W. 7th Ave., Ste 1380
Anchorage, AK 99501-3561

Alaska Department of Transportation
ATTN: Lance Wilbur, AICP
Central Region
4111 Aviation Ave.
Anchorage, AK 99501

Alaska Railroad Corporation
ATTN: Christopher Aadnesen
P.O. Box 107500
Anchorage, AK 99510

Ted Stevens Anchorage International Airport
ATTN: John Parrot
PO Box 196960
Anchorage, AK 99519

Anchorage Assembly
ATTN: Barbara Gruenstein
P.O. Box 196650
Anchorage, AK 99519

Municipality of Anchorage
ATTN: Debbie Sedwick
Anchorage Community Development Authority
245 W. 5th Ave., Ste. 122
Anchorage, AK 99501

Municipality of Anchorage
ATTN: Greg Jones
Community Planning & Development
4700 Elmore Road
Anchorage, AK 99507

Port MacKenzie
ATTN: Marc VanDongen
Matanuska-Susitna Borough
350 East Dahlia Ave
Palmer, AK 99645

Port of Anchorage
ATTN: William Sheffield
2000 Anchorage Port Rd.
Anchorage, AK 99501

Eagle River Community Council
ATTN: Michael Foster
13135 Old Glenn Hwy
Ste 200
Eagle River, AK 99577

Fairview Community Council
ATTN: Sharon Chamard
1121 E. 10th Ave.
Anchorage, AK 99501

Government Hill Community Council
ATTN: Bob French
P. O. Box 101677
Anchorage, AK 99510

Mountain View Community Council
ATTN: Don Crandall
P.O. Box 142824
Anchorage, AK 99514

Northeast Community Council
ATTN: Kevin Smestad
7600 Boundary Ave
Anchorage, AK 99504

Municipality of Anchorage
ATTN: Dan Sullivan
632 W. Sixth Ave.
Suite 840
Anchorage, AK 99501

Congressman Don Young
ATTN: Michael Anderson
2111 Rayburn House Office Building
Washington, DC 20515-0201

Congressman Don Young
ATTN: Chad Padgett
510 L Street
Suite 580
Anchorage, AK 99501

Senator Mark Begich
ATTN: Susanne Fleek
510 L Street
Suite 750
Anchorage, AK 99501

Senator Mark Begich
ATTN: David Ramseur
144 Russell Senate Office Building
Washington, DC 20510

Senator Lisa Murkowski
ATTN: Karen Knutson
709 Hart Senate Office Building
Washington, DC 20510-0202

Senator Lisa Murkowski
ATTN: Kevin Sweeney
510 L Street
Suite 550
Anchorage, AK 99501

State of Alaska
ATTN: Sean Parnell
PO Box 110001
Juneau, AK 99811-0001

Alaska Resources Library and Information Services
3211 Providence Dr.
Suite 111
Anchorage, AK 99508

Alaska State Court Law Library
303 K Street
Anchorage, AK 99501

Alaska State Library
P.O. Box 110571
Juneau, AK 99811

Delta Community Library
2291 Deborah St.
Delta Junction, AK 99737

Eagle Public Library
P.O. Box 45
Eagle, AK 99738

Fairbanks North Star Borough
Noel Wien Library
1215 Cowles St.
Fairbanks, AK 99701

Joint Base Elmendorf Richardson Library
123 Chilkoot Ave.
JBER, AK 99505

Lime Village School Library
P.O. Box LVD, Lime Village VIA
McGrath, AK, AK 99627

Martin Monsen Regional Library
P.O. Box 147
Naknek, AK 99633

Tanana Community and School Library
P.O. Box 109
Tanana, AK 99777

University of Alaska Fairbanks
Elmer E. Rasmuson Library
P.O. Box 756811
Fairbanks, AK 99775

Wasilla Public Library
391 N. Main St.
Wasilla, AK 99654

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673D AIR BASE WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

MEMORANDUM FOR SEE DISTRIBUTION

DEC 2 2010

FROM: 673 CES/CC
6326 Arctic Warrior Drive
Joint Base Elmendorf-Richardson AK 99506-3240

SUBJECT: F-22 Plus-Up Environmental Assessment

1. The United States Air Force (Air Force) is preparing an F-22 Plus-Up Environmental Assessment (EA) to evaluate the potential environmental consequences of a proposal to add seven F-22 aircraft to the Joint Base Elmendorf-Richardson (JBER) inventory. The proposed action would replace F-15 aircraft which were relocated from JBER in September 2010. Under the F-22 Beddown Environmental Assessment completed in 2006, two of the three F-15 squadrons left JBER and two F-22 squadrons arrived. Subsequently, the third F-15 squadron was reassigned from JBER. This Plus-Up EA will address two alternatives: the proposed addition of seven F-22 aircraft to the existing F-22 squadrons and the No Action alternative. The Proposed Action under consideration would not require expansion of existing airspace or construction of any new facilities.

2. The Air Force will publish a notice of EA preparation in the Anchorage Daily News, the Mat-Su Valley Frontiersman, and the Eagle River Star.

3. Please return the enclosed postcard by January 6, 2011 to confirm your receipt of this notification, and let us know if you have any general concerns that could be addressed in the upcoming EA. If you believe this proposal will significantly affect any tribal right or protected tribal resource, we invite you to consult with us on a government-to-government basis, in accordance with the Department of Defense *American Indian and Alaska Native Policy* and Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments*. Please write to us, or use the enclosed post card, and tell us which tribal rights or protected tribal resources will be affected and how they will be significantly affected. If you would like to consult with us, we will determine times which may be mutually convenient.

4. In order to give your initial comments or concerns consideration early in the development of this EA, I would appreciate receiving your response by January 6, 2011. If you have any specific questions about the proposal, please feel free to contact Ms. Ellen Godden at the above address or at (907) 552-7483. General questions may be directed to Mr. Bob Hall at (907) 552-8152. Thank you for your assistance in this matter.

J. DAVID NORTON, Lt Col, USAF
Commander

Attachments:
1. Distribution List
2. Postcard

F-22 Plus-Up Environmental Assessment
Joint Base Elmendorf-Richardson, Alaska
Alaska Native Villages
EA Memorandum Distribution List

Native Village of Cantwell
ATTN: Veronica Nicholas
P.O. Box 94
Cantwell, AK 99729

Chalkyitsik Village
ATTN: William Salmon, Jr.
PO Box 57
Chalkyitsik, AK 99788

ATTN: Gary Harrison
Chickaloon Native Village
PO Box 1105
Chickaloon, AK 99647

Circle Native Community (IRA)
ATTN: Larry Nathaniel
PO Box 89
Circle, AK 99733

Native Village of Crooked Creek
ATTN: Evelyn Thomas
P.O. Box 69
Crooked Creek, AK 99575

Village of Dot Lake
ATTN: William Miller
PO Box 2279
Dot Lake, AK 99737

Native Village of Eagle (IRA)
ATTN: Conan Goebel
PO Box 19
Eagle, AK 99738

Eklutna Native Village
ATTN: Dorothy Cook
26339 Eklutna Village Road
Chugiak, AK 99567

Gwichyaa Zhee Gwich'in Tribal Govt. (Native Village of Fort Yukon (IRA))
ATTN: Michael Peter
P.O. Box 126
Fort Yukon, AK 99740-0126

Healy Lake Village
ATTN: JoAnn Polston
PO Box 74090
Fairbanks, AK 99706

Igiugig Village
ATTN: AlexAnna Salmon
P.O. Box 4008
Igiugig, AK 99613-4008

Village of Iliamna
ATTN: Harvey Anelon
P.O. Box 286
Iliamna, AK 99606

Kaltag Tribal Council
ATTN: Donna Esmailka
P.O. Box 129
Kaltag, AK 99748

King Salmon Tribe
ATTN: Ralph Angasan, Sr
P.O. Box 68
King Salmon, AK 99613-0068

Knik Village
ATTN: Debra Call
PO Box 871565
Wasilla, AK 99687

Kokhanok Village
ATTN: John Nelson
P.O. Box 1007
Kokhanok, AK 99606

Lime Village Traditional Council
ATTN: Jennifer John
P.O. Box LVD, Lime Village VIA
McGrath, AK, AK 99627

Louden Tribal Council
ATTN: Chris Sommer
100 Tiger Hwy.
Galena, AK 99741

McGrath Native Village Council
ATTN: Carolyn Vanderpool
P.O. Box 134
McGrath, AK 99627

Naknek Native Village
ATTN: Patrick Peterson, Jr.
P.O. Box 106
Naknek, AK 99633

Nenana Native Association
ATTN: William Lord
P.O. Box 356
Nenana, AK 99760

New Koliganek Village Council
ATTN: Herman Nelson, Sr.
P.O. Box 5057
Koliganek, AK 99576

New Stuyahok Village
ATTN: Evan Wonhda
P.O. Box 49
New Stuyahok, AK 99636

Newhalen Village
ATTN: Raymond Wassillie
P.O. Box 207
Newhalen, AK 99606

Nondalton Village
ATTN: Jack Hobson
P.O. Box 49
Nondalton, AK 99640

Pedro Bay Village Council
ATTN: Keith Jensen
P.O. Box 47020
Pedro Bay, AK 99647

Red Devil Traditional Council
ATTN: Mary Willis
P.O. Box 61
Red Devil, AK 99656

Ruby Tribal Council
ATTN: Patrick McCarty
P.O. Box 210
Ruby, AK 99768

Sleetmute Traditional Council
ATTN: Pete Mellick
P.O. Box 109
Sleetmute, AK 99668

Village of Stony River
ATTN: Mary Willis
P.O. Box SRV
Stony River, AK 99557

Tanacross Village Council
ATTN: Roy Danny
P.O. Box 76009
Tanacross, AK 99776

Native Village of Tanana (IRA)
ATTN: Julia Roberts-Hyslop
P.O. Box 130
Tanana, AK 99777

Native Village of Tyonek
ATTN: Angela Sandstol
PO Box 82009
Tyonek, AK 99682

Native Village of Venetie Tribal Government (IRA)
ATTN: Julian Roberts
P.O. Box 81080
Venetie, AK 99781

Venetie Village Council
ATTN: Mary Gamboa
P.O. Box 81119
Venetie, AK 99781

Evelyn Thomas
Native Village of Crooked Creek
P.O. Box 69
Crooked Creek AK 99575

$0.44 0
US POSTAGE
FIRST-CLASS
062S0006976096
83702

673 CES/CEAO
Attention: Ms. Ellen Godden
6326 Arctic Warrior Drive
Elmendorf AFB, AK 99506-2850

995065322i C099

F-22

F-22 Plus-Up Environmental Assessment (EA)
Joint Base Elmendorf - Richardson

☐ We have specific comments on this proposed project and will provide them by **January 6, 2011.**

☒ We have brief, general comments, and these include:
We need military Protection & we need these Planes to Protect us.

☐ We have no comments on the proposed project at this time, but would like to continue to receive information.

☐ Please correct the contact information and direct future correspondence to:

Dorothy Cook
Eklutna Native Village
26339 Eklutna Village Road
Chugiak AK 99567

stamps.com
$0.44 0
US POSTAGE
FIRST-CLASS
062S0006976096
83702
833469.25

673 CES/CEAO
Attention: Ms. Ellen Godden
6326 Arctic Warrior Drive
Elmendorf AFB, AK 99506-2850

99506$3221 C099

F-22

F-22 Plus-Up Environmental Assessment (EA)
Joint Base Elmendorf - Richardson

- [ ] We have specific comments on this proposed project and will provide them by **January 6, 2011**.

- [ ] We have brief, general comments, and these include:

____

____

____

- [x] We have no comments on the proposed project at this time, but would like to continue to receive information.

- [ ] Please correct the contact information and direct future correspondence to:

____

____

____

Michael Peter
Gwichyaa Zhee Gwich'in Tribal Govt. (Native Village of Fort
Yukon (IRA))
P.O. Box 126
Fort Yukon AK 99740-0126

stamps
$0.44^0
US POSTAGE
FIRST-CLASS
062S0006976096
83702
B33469 24

673 CES/CEAO
Attention: Ms. Ellen Godden
6326 Arctic Warrior Drive
Elmendorf AFB, AK 99506-2850

99506$3221 C099

F-22

F-22 Plus-Up Environmental Assessment (EA)
Joint Base Elmendorf - Richardson

☐ We have specific comments on this proposed project and will provide them by **January 6, 2011.**

☐ We have brief, general comments, and these include:

____

____

____

☒ We have no comments on the proposed project at this time, but would like to continue to receive information.

☐ Please correct the contact information and direct future correspondence to:

____

____

____

AlexAnna Salmon
Igiugig Village
P.O. Box 4008
Igiugig AK 99613-4008

$0.44 0
US POSTAGE
FIRST-CLASS
062S0006976096
83702

DEC 15 2010

673 CES/CEAO
Attention: Ms. Ellen Godden
6326 Arctic Warrior Drive
Elmendorf AFB, AK 99506-2850

99506$3221 C099

F-22

F-22 Plus-Up Environmental Assessment (EA)
Joint Base Elmendorf - Richardson

☐ We have specific comments on this proposed project and will provide them by **January 6, 2011**.

☐ We have brief, general comments, and these include:

____

____

____

☑ We have no comments on the proposed project at this time, but would like to continue to receive information.

☐ Please correct the contact information and direct future correspondence to:

____

____

____

Jennifer John
Lime Village Traditional Council
P.O. Box LVD, Lime Village VIA
McGrath, AK AK 99627

$0.44 0
US POSTAGE
FIRST-CLASS
062S0006976096
83702

673 CES/CEAO
Attention: Ms. Ellen Godden
6326 Arctic Warrior Drive
Elmendorf AFB, AK 99506-2850

F-22

F-22 Plus-Up Environmental Assessment (EA)
Joint Base Elmendorf - Richardson

☐ We have specific comments on this proposed project and will provide them by **January 6, 2011**.

☐ We have brief, general comments, and these include:

____

____

____

☒ We have no comments on the proposed project at this time, but would like to continue to receive information.

☐ Please correct the contact information and direct future correspondence to:

____

____

____

Chris Sommer
Louden Tribal Council
100 Tiger Hwy.
Galena AK 99741

$0.440
US POSTAGE
FIRST-CLASS
062S0006976096
83702

673 CES/CEAO
Attention: Ms. Ellen Godden
6326 Arctic Warrior Drive
Elmendorf AFB, AK 99506-2850

995083221 C099

F-22

F-22 Plus-Up Environmental Assessment (EA)
Joint Base Elmendorf - Richardson

☐ We have specific comments on this proposed project and will provide them by **January 6, 2011**.

☐ We have brief, general comments, and these include:

____

____

____

☒ We have no comments on the proposed project at this time, but would like to continue to receive information.

☐ Please correct the contact information and direct future correspondence to:

____

____

____

Jack Hobson
Nondalton Village
P.O. Box 49
Nondalton AK 99640

$0.44 0
US POSTAGE
FIRST-CLASS
062S0006976096
83702

673 CES/CEAO
Attention: Ms. Ellen Godden
6326 Arctic Warrior Drive
Elmendorf AFB, AK 99506-2850

F-22 Plus-Up Environmental Assessment (EA)
Joint Base Elmendorf - Richardson

F-22

☐ We have specific comments on this proposed project and will provide them by **January 6, 2011**.

☐ We have brief, general comments, and these include:

____

____

____

☒ We have no comments on the proposed project at this time, but would like to continue to receive information.

☐ Please correct the contact information and direct future correspondence to:

____

____

____

Mary Willis
Village of Stony River
P.O. Box SRV
Stony River AK 99557

$0.44 0
US POSTAGE
FIRST-CLASS
062S0006976096
83702

673 CES/CEAO
Attention: Ms. Ellen Godden
6326 Arctic Warrior Drive
Elmendorf AFB, AK 99506-2850

F-22

F-22 Plus-Up Environmental Assessment (EA)
Joint Base Elmendorf - Richardson

☐ We have specific comments on this proposed project and will provide them by **January 6, 2011**.

☐ We have brief, general comments, and these include:

____

____

____

☑ We have no comments on the proposed project at this time, but would like to continue to receive information.

☐ Please correct the contact information and direct future correspondence to:

____

____

____

Pete Mellick
Sleetmute Traditional Council
P.O. Box 109
Sleetmute AK 99668

SLEETMUTE, AK
DEC 09 2010
USPS

$0.440
US POSTAGE
FIRST-CLASS
062S0006976096
83702

673 CES/CEAO
Attention: Ms. Ellen Godden
6326 Arctic Warrior Drive
Elmendorf AFB, AK 99506-2850

9950683221 C099

F-22

F-22 Plus-Up Environmental Assessment (EA)
Joint Base Elmendorf - Richardson

☒ We have specific comments on this proposed project and will provide them by **January 6, 2011**.

☐ We have brief, general comments, and these include:

____

____

____

☐ We have no comments on the proposed project at this time, but would like to continue to receive information.

☐ Please correct the contact information and direct future correspondence to:

____

____

____

AGR Judy
Received

DEC 0 7 2010

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673D AIR BASE WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

DEC 2

MEMORANDUM FOR U.S. Fish and Wildlife Service
ATTN: Ms. Ann Rappoport
605 W. 45h Ave., Room G61
Anchorage, AK 99501-2250

FROM: 673 CES/CC
6326 Arctic Warrior Drive
Joint Base Elmendorf-Richardson AK 99506-3240

SUBJECT: F-22 Plus-Up Environmental Assessment

1. The United States Air Force (Air Force) is preparing an F-22 Plus-Up Environmental Assessment (EA) to assess the potential environmental consequences of a proposal to locate 7 additional operational F-22 aircraft at Joint Base Elmendorf-Richardson (JBER). The 2006 F-22A Beddown Environmental Assessment analyzed a proposal of 18 F-15C and 40 F-22 aircraft and assumed an average of 5,500 fighter sorties per year. The current proposal would give JBER 0 F-15C and 47 F-22 aircraft with an estimated annual sortie rate of 4,510 per year, reducing both the total number of fighter aircraft and the estimated sortie rate. The EA will address the proposed action, action alternatives, and a no action alternative.

2. The Air Force began the public scoping period this month and will publish a notice of EA preparation in the Anchorage Daily News and Eagle River Star.

3. Pursuant to analysis of the proposed additional aircraft and to support compliance with the Endangered Species Act, we would like to request information regarding federally listed threatened, endangered candidate, and proposed to be listed species that occur or may occur in the potentially affected area. Please send this information to our primary point of contact at: 673 CES/CEAO, Attn: Ms. Ellen Godden, 6326 Arctic Warrior Drive, Joint Base Elmendorf-Richardson AK 99506-3240. Please provide any preliminary agency comments or information regarding the proposed additional aircraft not later than January 15, 2011 in order to be incorporated in the preparation of the draft EA. Additionally, we would appreciate your identifying a point of contact for any follow-up questions we may have.

4. If you have any specific questions about the proposal, we would like to hear from you. The primary point of contact is Ms. Ellen Godden, (907) 552-7483 and an alternate point of contact is Ms. Valerie Payne, (907) 552-7111. Thank you for your assistance in this matter.

Called on the 8th of Feb.
Draft EA out on March
Elizabeth.Godden@elmendorf.af.mil

J. DAVID NORTON, Lt Col, USAF
Commander

The U.S. Fish and Wildlife Service (USFWS) has reviewed the plans for this proposed project, relative to Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA) (16 U.S.C. 1531 et. seq.). Our records indicate that there are no federally listed or proposed species and/or designated or proposed critical habitat within the action area of the proposed project. Therefore, no further action is required regarding the ESA.

If you have further questions regarding this project, please contact our office, U.S. Fish and Wildlife Service, 605 W. 4th Ave., Rm. G-61, Anchorage, AK 99501 Ph: (907) 271-2888, Fax: (907) 271-2786

FWS Log No. 2011-SL-0064

Endangered Species Biologist 2/8/11 **Date**

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673D AIR BASE WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

12 Oct 10

MEMORANDUM FOR NOAA Fisheries' National Marine Fisheries Service
Protected Resources Division and Habitat Conservation Divisions
Attn: Mr. Brad Smith
222 West 7th Avenue, Box 43
Anchorage, AK 99513

FROM: 673 CES/CC
6326 Arctic Warrior Drive
Joint Base Elmendorf-Richardson AK 99506-3240

SUBJECT: F-22 Supplemental Environmental Assessment

1. The United States Air Force (Air Force) is preparing a Supplemental Environmental Assessment (EA) to assess the potential environmental consequences of a proposal to locate 7 additional operational F-22 aircraft at Joint Base Elmendorf-Richardson (JBER). The 2006 F-22A Beddown Environmental Assessment analyzed a baseline of 18 F-15C and 40 F-22 aircraft and assumed an average of 5,500 fighter sorties per year. This proposal would give JBER 0 F-15C and 47 F-22 aircraft with an estimated annual sortie rate of 4,510 per year, reducing both the total number of fighter aircraft and the estimated sortie rate. The Supplemental EA will address the proposed action, action alternatives, and a no action alternative.

2. The Air Force will begin the public scoping period later in October or early November and will publish a notice of EA preparation in the Anchorage Daily News and Eagle River Star.

3. Pursuant to analysis of the proposed additional aircraft and to support compliance with the Endangered Species Act, we would like to request information regarding federally listed threatened, endangered candidate, and proposed to be listed species that occur or may occur in the potentially affected area. Please send this information to our primary point of contact at: 673 CES/CEAO, Attn: Ms. Ellen Godden, 6326 Arctic Warrior Drive, Joint Base Elmendorf-Richardson AK 99506-3240. Please provide any preliminary agency comments or information regarding the proposed additional aircraft not later than January 15, 2011 in order to be incorporated in the preparation of the draft EA. Additionally, we would appreciate your identifying a point of contact for any follow-up questions we may have. We would like to meet with your point of contact to discuss how to proceed with this consultation as soon as possible.

4. If you have any specific questions about the proposal, we would like to hear from you. The primary point of contact is Ms. Ellen Godden, (907) 552-7483 and an alternate point of contact is Ms. Valerie Payne, (907) 552-3376. Thank you for your assistance in this matter.

J. David Norton

J. DAVID NORTON, Lt Col, USAF
Commander

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

November 1, 2010

673 CES/CEAO
Attn: Ms. Ellen Godden
6326 Arctic Warrior Drive
Joint Base Elmendorf-Richardson, AK
99506-3240

RE: Location of additional aircraft at Joint Base Elmendorf-Richardson (JBER)

Dear Ms. Godden:

The National Marine Fisheries Service (NMFS) has received your Oct. 12, 2010 Memorandum requesting information on threatened or endangered species associated with the addition of 7 operational F-22 aircraft at Joint Base Elmendorf-Richardson (JBER). NMFS offers the following information under the Endangered Species Act (ESA) and the Essential Fish Habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation Management Act (Magnuson-Stevens Act).

Threatened and Endangered Species
Section 7(a)(2) of the ESA directs Federal interagency cooperation "to insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species" or result in the destruction or adverse modification of critical habitat. NMFS is responsible for the administration of the ESA as it applies to listed cetaceans, pinnipeds, fish, and reptiles (sea turtles) in Alaska. Further information on NMFS ESA species can be found at:
http://www.nmfs.noaa.gov/pr/species/esa_species.htm.

Endangered Species
NMFS designates those species or distinct stocks of species, which are in jeopardy of extinction as endangered under the ESA. An endangered species is defined in the law as "any species, which is in danger of extinction throughout all or a significant portion of its range." Cook Inlet beluga whales (*Delphinapterus leucus*), which are listed as endangered under the ESA, are frequently sighted in waters adjacent to the project and must be considered when evaluating the effects of the project. Critical habitat for the Cook Inlet beluga is currently being proposed and may require evaluation as well.

Marine/Anadromous Fish
Several ESA-listed stocks of Pacific salmon may occur within Alaska's waters. These include the following Evolutionarily Significant Units (ESU): Snake River fall Chinook (T), Snake River spring/summer Chinook (T), Puget Sound Chinook (T), Upper Columbia River spring Chinook (E), Lower Columbia River Chinook (T), Upper Columbia River steelhead (E), Upper

Willamette River steelhead (T), Middle Columbia River steelhead (T), Lower Columbia River steelhead (T), and Snake River basin steelhead (T). These stocks range throughout the North Pacific. However, the specific occurrence of listed salmonids within the project areas is unlikely.

A detailed stock assessment report providing information (geographic range, a minimum population estimate, current population trends, current and maximum net productivity rates, optimum sustainable population levels and allowable removal levels, and estimates of annual human-caused mortality and serious injury through interactions with commercial fisheries and subsistence hunters) on the marine mammals of Alaska under jurisdiction of NMFS can be found at: http://www.fakr.noaa.gov/protectedresources/default.htm. Additional information regarding the ESA is available on our website at: http://www.nmfs.noaa.gov/pr/laws/esa/.

Please be advised that other non-listed marine mammals may also be in the area and are protected under the Marine Mammal Protection Act (MMPA). Information regarding the MMPA may be found at: http://www.nmfs.noaa.gov/pr/laws/mmpa/.

Essential Fish Habitat

Under Section 305(b)(2) of the Magnuson-Stevens Act, Federal agencies are required to consult with the Secretary of Commerce on any action that may adversely affect EFH. EFH has been designated in waters used by anadromous salmon and various life stages of marine fish under NMFS' jurisdiction. Five fishery management plans exist for fisheries in Alaska. They cover groundfish in the Gulf of Alaska, groundfish in the Bering Sea and Aleutian Islands, crab in the Bering Sea and Aleutian Islands, and salmon and scallops statewide. Please visit our web site at http://www.fakr.noaa.gov/habitat for additional information on habitat and EFH information.

We hope this information is useful in fulfilling your requirements under section 7 of the ESA and section 305(b)(2) of the Magnuson-Stevens Act. Please direct any questions regarding marine mammals or endangered species to Kate Savage at (907) 586-7312 (*Kate.Savage@noaa.gov*), and questions regarding EFH to Brian Lance at (907) 271-1301 (*Brian.Lance@noaa.gov*).

Sincerely,

James W. Balsiger, Ph.D.
Administrator, Alaska Region

cc: Brad Smith

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673D AIR BASE WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

11-21-11

MEMORANDUM FOR NOAA Fisheries' National Marine Fisheries Service
Protected Resources Division and Habitat Conservation Divisions
Attn: Ms. Kate Savage

FROM: 673 CES/CC
6326 Arctic Warrior Drive
Joint Base Elmendorf-Richardson AK 99506-3240

SUBJECT: Wildlife Analysis for F-22 Supplemental Environmental Assessment

1. The United States Air Force (Air Force) is preparing an F-22 Plus-Up Environmental Assessment (EA) to evaluate the potential environmental consequences of the proposal to add six primary and one back-up F-22 aircraft to the Joint Base Elmendorf-Richardson (JBER) F-22 inventory, an increase in primary aircraft of approximately 17 percent. The purpose of the proposed plus-up is to provide additional Air Force capabilities at a strategic location to meet mission responsibilities for worldwide deployment. Additional F-22 aircraft are needed at JBER to provide U.S. Air Force capability to respond efficiently to national objectives, be available for contingencies, and enhance F-22 operational flexibility.

2. Pursuant to analysis of the proposed additional aircraft and to support compliance with the Endangered Species Act, we initiated an informal consultation in Oct 2010 and received information regarding federally listed threatened, endangered, candidate, and proposed to be listed species that occur or may occur in the potentially affected area from your office on 1 Nov 2010. Having reviewed the provided information, we are pleased to submit the attached Section 7 (Endangered Species Act) Compliance Wildlife Analysis for F-22 Plus-Up Environmental Assessment, Joint Base Elmendorf-Richardson (JBER) Alaska. A determination of "may affect not likely to adversely affect" is found for all species analyzed. We request your concurrence with the "the may affect not likely to adversely affect" determination with regard to species covered by your agency.

3. If you have any specific questions about the wildlife analysis or the proposal, please contact us. The primary point of contact is Ms. Ellen Godden, (907) 552-7483 and an alternate point of contact is Ms. Valerie Payne, (907) 552-3376. Thank you for your assistance in this matter.

J. DAVID NORTON, Lt Col USAF
Commander

Attachment:
Wildlife Analysis

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

February 22, 2011

Ms. Ellen Godden
673 CES/CEAOP
6326 Arctic Warrior Drive
Joint Base Elmendorf-Richardson, AK 99506-3240

Dear Ms. Godden:

The National Marine Fisheries Service (NMFS) has reviewed the "Section 7 (Endangered Species Act) Compliance Wildlife Analysis for F-22 Plus-Up Environmental Assessment" (EA), dated February 11, 2011. In your letter to NMFS, you requested concurrence that the proposed action "may affect, but is not likely to adversely affect", federally listed threatened, endangered or proposed species under NMFS' jurisdiction, including the Cook Inlet Beluga Whale and Western Distinct Population Segment (DPS) of Steller Sea Lion. An agency action is considered not likely to adversely affect listed species or designated critical habitat when its effects are expected to be completely beneficial, discountable, or insignificant. Beneficial effects are synchronous positive effects without any adverse effects to the species or critical habitat. Discountable effects are those extremely unlikely to occur. Insignificant effects relate to the size of the impact and may not reach the scale where take occurs. Based on best judgment, a person would not expect discountable effects to occur; or be able to meaningfully measure, detect or evaluate insignificant effects. The EA also considered project impacts on the five Primary Constituent Elements (PCE) of the proposed Cook Inlet beluga whale critical habitat (74 FR 63095, December 2, 2009) with the determination that the project would not result in adverse modification of the proposed critical habitat.

Summary of EA

The action concerns the addition of six primary and one backup F-22 aircraft to the existing fleet of 36 primary and three backup F-22 aircraft located at Joint Base Elmendorf-Richardson (JBER), Alaska. The increase of the six operational aircraft would increase the number of F-22 sorties by approximately 21 percent. The action area encompasses portions of the Knik Arm that are overflown by F-22 aircraft on established approach, departure and reentry patterns to the west and north of JBER runways. Two ESA listed species were included in the assessment, the Cook Inlet beluga whale and Steller sea lion.

Regarding Cook Inlet beluga whales (*Delphinapterus leucus*), both individuals and groups are seasonally common in Knik Arm adjacent to JBER. Whales have been noted milling, foraging and socializing in river mouths near Six Mile Creek, North Eagle Bay, Eagle River and Point McKenzie, primarily coincident with the coho salmon run. The greatest number of whales in Knik Arm has generally been observed between August and November, with the whales tending to move north into Knik Arm with the flooding tide, usually within one mile of the eastern shore, and move south out of Knik Arm on the ebbing tide, usually within one mile of the western shore. In or adjacent to JBER, whales have been observed in Eagle Bay and also occasionally feeding at the mouth of Six Mile Creek. Although up to 71 whales have been seen in Eagle Bay during a single summer observation, the average daily visits to the area included nine whales.

The EA then assessed impacts of the action on the Cook Inlet beluga whale, which include acoustic and visual disturbance. Because acoustic disturbance is the predominant impact of the action, the sound profile of the additional F-22's was evaluated in relation to the five major categories of acoustic effect, including 1. Direct trauma; 2. Auditory fatigue; 3. Auditory masking; 4. Stress response; and 5. Behavioral reactions. Neither direct trauma nor auditory fatigue was a predicted outcome of the action based on the level and duration of the modeled F-22 sound profile. The maximum sound pressure level of an F-22 overflight within water was calculated at 137 dB re 1 μPa for a duration of a few seconds, which was not considered sufficiently intense or long-lasting to result in direct trauma or auditory fatigue. Auditory masking was not expected because the F-22 overflight noise levels are close enough to ambient noise, which normally exceeds 120 dB re 1 μPa in the area, and are of very short duration. Regarding stress response and behavioral reactions, an analytical model was used to quantify potential behavioral disturbances based on predicted sound levels, animal threshold reactions to similar sounds and Cook Inlet beluga whale density. Based upon the results of all flight profiles, the number of behavioral reactions was conservatively estimated at less than 0.04 individuals per year. Additional factors for consideration included the possibility of habituation, the sound frequency of jet engines being predominantly lower than the best hearing range of belugas, the very brief duration of exposure and high ambient noise levels in the area. The likelihood of behavioral reaction was summarized as discountable. Potential visual impacts were considered minimal because of the flight altitude (weighted average of closest approach to water was 2,250 feet MSL for all flight paths), small size of the aircraft and rapidity of flight. Based on the acoustic and visual impact assessments, it was concluded that the project may affect, but is not likely to adversely affect the Cook Inlet beluga whale.

Project effects were also analyzed relative to the five Primary Constituent Elements of the proposed Cook Inlet beluga whale critical habitat. No effects were expected on water quality or hydrology, prey species or beluga whale passage within or between critical habitat, no introduction of toxins or harmful substances was expected and in water noise levels were not expected to result in the abandonment of habitat. It was concluded that the project would not result in adverse modification of the proposed critical habitat of the Cook Inlet beluga whale.

Regarding Steller sea lions (*Eumetopias jubatus*), the presence of the species is considered very rare in Knik Arm and the EA included the sighting of a single animal in 2009. With respect to potential impacts on Steller sea lions, the EA determined that, because the species does not normally occur in the action area, the combined likelihood of an occurrence and elevated F-22 noise event is discountable. Therefore, the action may affect, but is not likely to adversely affect the Western DPS of Steller sea lion.

Discussion

A. Cook Inlet Beluga Whale

The Cook Inlet beluga stock has probably always numbered fewer than several thousand animals, but has declined significantly from its historical abundance. In 1979, the Cook Inlet beluga stock was estimated at 1300 animals (Calkins 1989), which subsequently decreased to 653 animals in 1994 and to an estimated 340 in 2010 (NMFS 2010).

Beluga whales use sound rather than sight for many important functions, including communication, prey location and navigation. In Cook Inlet, beluga whales must compete acoustically with natural and anthropogenic sounds. Man-made sources of noise in Cook Inlet include large and small vessels, aircraft, oil and gas drilling, marine seismic surveys, pile driving, and dredging. The effects of man-made noise on beluga whales depend on several factors including the intensity, frequency and duration of the noise, the location and behavior of the whale, and the acoustic nature of the environment. High frequency noise diminishes more rapidly than lower frequency noises. Sound also dissipates more rapidly in shallow waters and over soft bottoms (sand and mud). Much of upper Cook Inlet is characterized by its shallow depth, sand/mud bottoms, and high background noise from currents and glacial silt (Blackwell and Greene 2002) thereby making it a poor acoustic environment.

Anthropogenic noise above ambient levels and within the same frequencies used by belugas may mask communication between these animals. At louder levels, noise may result in disturbance and harassment, or cause temporary or permanent damage to the whales' hearing. Although captive beluga whales have provided some insight into beluga hearing and the levels of noise that might damage their hearing capabilities, much less information is available on how noise might impact beluga whales behaviorally in the wild. In the Canadian high Arctic, beluga whales were observed to react to ice-breaking ships at distances of more than 80 km, showing strong avoidance, apparent alarm calls, and displacement (Finley et al. 1990). However, in less pristine, more heavily trafficked areas belugas may habituate to vessel noise.

Beluga whales have a well-developed sense of hearing and echolocation. These whales hear over a large range of frequencies, from about 40-75 Hertz (Hz) to 30-100 kiloHertz (kHz) (Richardson 1995), although their hearing is most acute at relatively high frequencies, between 10 and 100 kHz (Blackwell and Greene 2002), which is generally above the level of much industrial noise. The beluga whales' hearing falls off rapidly above 100 kHz. However, beluga whales may hear sounds as low as 40-75 Hz, although this noise would have to be very loud. Jet aircraft noise is most intense in relatively low frequency bands, primarily below 4 kHz.

Cook Inlet experiences significant levels of aircraft traffic. The Anchorage International Airport is directly adjacent to lower Knik Arm and has high volumes of commercial and cargo air traffic. Lake Hood and Spenard Lake in Anchorage are also heavily used by recreational seaplanes. Even though sound is attenuated by water surface, Blackwell and Green (2002) found that aircraft noise can be quite loud underwater when jet aircraft are directly overhead. Belugas may be less sensitive to aircraft noise than vessel noise, but individual responses may be highly variable and depend on the beluga's previous experiences, its activity at the time of the noise, and the characteristics of the noise. The area around lower Knik Arm, including the Port of Anchorage, is typically characterized by high levels of ambient noise. The EA cites levels as high as 143 re 1 μPa on shipping days for the Port of Anchorage and background levels rarely below 125 dB re 1 μPa. NMFS considers the Level A in-water harassment threshold to be 180 dB re 1 μPa for cetaceans. Level B harassment from pulsed noise is 160 dB re 1 μPa and 125 dB re 1 μPa from non-pulsed noise. Of the seven flight paths assessed, sound pressure levels (SPL) ranged from 117.3 to 137 dB re 1 μPa. The number of additional events at the maximum SPL was approximately 1.5 per day. Given the high ambient noise in the area, the low number of additional daily events which would be complete in a matter of seconds and the low probability of animals within the path of maximum SPL, the likelihood of behavioral change due to the additional F-22s is insignificant.

Beluga whales may also respond to visual disturbance. In the Beaufort Sea, belugas were observed diving or swimming away when low-flying (<500 m) aircraft passed directly over them (Richardson 1995). However, in Cook Inlet little or no change was noted in beluga swim direction with small aircraft flying at approximately 800 ft, which was considered most likely due to beluga habituation to routine, small aircraft overflights (Rugh et al. 2000). As the weighted closest approach of all F-22 flight paths is 2,250 feet, the likelihood of visual disturbance from the F-22 aircraft is insignificant.

With the exception of the in-water acoustic impacts as addressed above, the action does not include marine components and will, therefore, not affect the PCEs for proposed critical habitat. NMFS agrees that the project will not result in adverse modification of proposed critical habitat of the Cook Inlet beluga whale.

In summary, NMFS concurs with the determination that the proposed action may affect, but is not likely to adversely affect, the population of Cook Inlet beluga whales as well as the determination that the action will not cause adverse modification to proposed critical habitat.

B. Steller sea lions

The Western DPS of Steller sea lion inhabit much of Alaskan coastal waters west of 144°. Within this area, sea lions may traverse and forage over great distances, moving onto terrestrial haulout sites for rest, molting and predator avoidance and seasonal rookery sites for reproductive activities. Critical habitat for Steller sea lions has been designated based on the spatial extent of foraging, prey location and on the location of terrestrial haulout and rookery sites (NMFS 2008). Upper Cook Inlet, including Knik Arm, does not support any Steller sea lion rookeries, haulouts or critical habitat. The species is rarely found there, with the Forelands generally considered the most northerly limit of Steller sea lion range in Cook Inlet (M. Migura, personal communication, NMFS). NMFS agrees that the combined likelihood of Steller sea lion presence in the action area and F-22 overflight exposure is discountable and that the action may affect, but is not likely to adversely affect, the western DPS of Steller sea lion.

Conclusion

NMFS concurs with your agency's determination that the planned action may affect, but is not likely to adversely affect, ESA-listed species or designated critical habitat under NMFS jurisdiction, including Cook Inlet beluga whale and the western population of Steller sea lion. NMFS also concurs that the action will not result in adverse modification of proposed critical habitat for the Cook Inlet beluga whale.

Re-initiation of consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) take of a listed species occurs, (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not considered, (3) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered, or (4) a new species is listed or critical habitat designated that may be affected by the action. Should any questions or concerns arise, please contact Kate Savage at *Kate.Savage@noaa.gov.*

Sincerely,

James W. Balsiger, Ph.D.
Administrator, Alaska Region

Cc: Brad Smith

List of References

Blackwell, S.B. and C.R. Greene, Jr. 2002. Acoustic measurements in Cook Inlet, Alaska, during 2001. Report from Greeneridge Sciences, Inc., Aptos, CA, for NMFS, Anchorage, AK.

Calkins, D.G. 1989. Status of Belukha whales in Cook Inlet. In: Gulf of Alaska, Cook Inlet and North Aleutian Basin information update meeting. L. E. Jarvela and L. Thorsteinson (eds.). Anchorage, AK., Feb 7-8, 1989. Anchorage, AK.: USDOC, NOAA,OCSEAP, p 109-112.

Finley, K.J., G.W. Miller, R.A. Davis, and C.R. Greene. 1990. Reactions of belugas, *Delphinapterus leucas*, and narwhals, *Monodon monoceros*, to ice-breaking ships in the Canadian high Arctic. Canadian Bulletin of Fisheries and Aquatic Sciences 224: 97-117.

NMFS (National Marine Fisheries Service). 2010. Cook Inlet beluga population up since 2009; Overall trend still downward. NOAA Fisheries release, October 8, 2010. Accessed Oct. 12, 2010 at: http://www.fakr.noaa.gov/newsreleases/2010/belugapopulation.htm.

NMFS (National Marine Fisheries Service). 2008. Recovery Plan for the Steller Sea Lion, Eastern and Western Distinct Population Segments (*Eumetopias jubatus*), Revision. National Marine Fisheries Service, Juneau, Alaska. 325 pp.

Richardson, W. J., Greene, C. R., Jr., Koski, W. R., Malme, C. I., Miller, G. W., Smultea, M. A., et al. 1990.Acoustic effects of oil production activities on bowhead and white whales visible during spring migration near Pt. Barrow, Alaska—1989 phase (OCS Study MMS 90- 0017; NTIS PB91-105486). LGL Ltd. report for U.S. Minerals Management Service, Herndon, VA. 284 pp.

Rugh, D., Shelden, K. and B. Mahoney. 2000. Distribution of beluga whales in Cook Inlet, Alaska, during June/July 1993 to 1999. Mar. Fish. Rev. 62 (3): 6 -21.

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673D AIR BASE WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

12 April 2011

MEMORANDUM FOR ALASKA DEPARTMENT OF NATURAL RESOURCES
OFFICE OF HISTORY AND ARCHAEOLOGY
ATTENTION: MS. JUDITH E. BITTNER

FROM: 673 CES/CC
6326 Arctic Warrior Drive
Joint Base Elmendorf-Richardson AK 99506-3240

SUBJECT: Statement of "No Adverse Effect" for Proposed Project

1. The 673d Air Base Wing (ABW) and the United States Air Force (USAF) are pleased to provide you a copy of the Environmental Assessment (EA) and Draft Finding of No Significant Impact (FONSI) for the proposed addition (plus-up) of seven F-22 aircraft to the Joint Base Elmendorf-Richardson (JBER) current inventory of 40 F-22 aircraft. The additional aircraft would train in existing Alaska airspace and would not require construction of any new facilities, or renovation of existing facilities.

2. As a federal undertaking, this project is subject to 36 Code of Federal Regulations (CFR) Part 800, the regulations implementing Section 106 of the National Historic Preservation Act (16 U.S. Code [USC] Section 470f); with this letter the 673d ABW is initiating consultation regarding the proposed F-22 plus-up.

3. Twenty-seven archaeological sites have been located at JBER. Twenty sites are recommended as ineligible for the NRHP, five are unevaluated, and two are considered eligible. There are 54 NRHP eligible buildings or structures on JBER-Elmendorf, most of which are located in one of three historic districts: the Flightline Historic District; the Alaska Air Depot Historic District; and the Generals' Quad Historic District. Other historic-eligible structures at JBER-Richardson include Buildings 1 and 3, along with those associated with the Nike Site Summit Historic District.

4. There would be no adverse effects to archaeological resources or NRHP-eligible architectural resources from the proposed undertaking, as there would be no construction of any new facilities, or renovation of existing facilities. There would be no adverse effects to historic buildings resulting from the small increase in noise associated with the plus-up since their NRHP eligibility is based, in part, on their association with an active Air Force installation at which jet aircraft routinely operate resulting in an elevated noise environment.

5. There would be no adverse effects to historic properties under the airspace as a result of the proposed F-22 plus-up. An increase in sonic booms, when discernible, may annoy users of land, but would not be expected to affect Alaska Native subsistence hunting.

6. Also in accordance with 36 CFR Part 800.2, the 673d ABW is seeking to include interested Alaska Native villages or Tribal governments. Notices of the intent to prepare the EA with enclosed stamped return postcards were sent to 35 Alaska Native villages and Tribal government entities. Nine Alaska Native villages returned the response postcards. No specific comments on the proposed F-22 plus-up from any Alaska Native village or Tribal government entity have been received to date.

7. Pursuant to 36 CFR Part 800.5 (b), we have determined that this undertaking will have "no adverse effect" on historic properties. We invite you to review the attached EA, and respectfully request your office concur with this determination as completion of our Section 106 consultation requirements under the National Historic Preservation Act.

8. If you have any questions, please contact Mr. Jon Scudder, 3 CES/CEAN, at 552-4157.

J. DAVID NORTON, Lt Col, USAF
Commander

Attachments:
1. Environmental Assessment
2. Distribution List

F-22 Plus-Up Environmental Assessment
Joint Base Elmendorf-Richardson, Alaska
Agency Coordination
EA Memorandum Distribution List

Federal Aviation Administration, Alaska Region
ATTN: Bob Lewis
222 West 7th Ave. #14
Anchorage, AK 99513

U.S. Department of Agriculture
ATTN: Robert Jones
Natural Resources Conservation Service
800 W. Evergreen Ave., Suite 100
Palmer, AK 99545-6539

U.S. Department of Interior
ATTN: Pamela Bergmann
Office of Environmental Policy
1689 C Street, Rm. 119
Anchorage, AK 99501

U.S. Department of Transportation
ATTN: David Miller
Federal Highway Administration
P.O. Box 21648
Juneau, AK 99802-1648

U.S. Department of Transportation
ATTN: Robert Bouchard
Maritime Administration
1200 New Jersey Ave., SE (mar-510,#w21-224
Washington, DC 20590

U.S. Department of Interior
ATTN: Edward Parisian
Bureau of Indian Affairs, Alaska Regional Office
P.O. Box 25520
Juneau, AK 99802

U.S. Department of Transportation
ATTN: Richard Krochalis
Federal Transit Administration, Regional 10
915 Second Ave., Ste. 3142
Seattle, WA 98174-1002

U.S. Fish and Wildlife Service
ATTN: Ann Rappoport
Anchorage Fish & Wildlife Field Office
605 4th Ave., Rm. G-61
Anchorage, AK 99501

United States Coast Guard
ATTN: CAPT Jason Fosdick
Sector Anchorage
510 L Street, Ste. 100
Anchorage, AK 99501

National Marine Fisheries Service
ATTN: Brad Smith
Protected Resources Div/Habitat Consrv
222 W. 7th Avenue, Rm. 517
Anchorage, AK 99513

National Park Service
ATTN: Sue Masica
Alaska Regional Office
240 W 5th Avenue, Room 114
Anchorage, AK 99501

Bureau of Land Management
ATTN: Gary Reimer
Anchorage District Office
4700 BLM Rd.
Anchorage, AK 99507

U.S. Environmental Protection Agency, Region 10
ATTN: Jacques Gusmano
222 West 7th Ave.
Room 537
Anchorage, AK 99513-7588

Alaska Department of Environmental Conservation
ATTN: Deb Caillouet
555 Cordova
Anchorage, AK 99501

Alaska Department of Fish and Game
ATTN: Mark Burch
Division of Wildlife Conservation
333 Raspberry Rd.
Anchorage, AK 99518-1599

Alaska Department of Military and Veterans Affairs
ATTN: MAJ GEN Thomas Katkus
PO Box 5800
Camp Denali
JBER, AK 99505

Alaska Department of Natural Resources
ATTN: Thomas Irwin
Office of the Commissioner
550 W. 7th Avenue, Suite 1400
Anchorage, AK 99501

Alaska Department of Natural Resources
ATTN: Judith Bittner
Office of History and Archaeology
550 W 7th Avenue, Ste. 1310
Anchorage, AK 99501

Alaska Department of Natural Resources
ATTN: James King
Parks and Outdoor Recreation
550 W. 7th Ave., Ste 1380
Anchorage, AK 99501-3561

Alaska Department of Transportation
ATTN: Lance Wilbur, AICP
Central Region
4111 Aviation Ave.
Anchorage, AK 99501

Alaska Railroad Corporation
ATTN: Christopher Aadnesen
P.O. Box 107500
Anchorage, AK 99510

Ted Stevens Anchorage International Airport
ATTN: John Parrot
PO Box 196960
Anchorage, AK 99519

Anchorage Assembly
ATTN: Barbara Gruenstein
P.O. Box 196650
Anchorage, AK 99519

Municipality of Anchorage
ATTN: Debbie Sedwick
Anchorage Community Development Authority
245 W. 5th Ave., Ste. 122
Anchorage, AK 99501

Municipality of Anchorage
ATTN: Greg Jones
Community Planning & Development
4700 Elmore Road
Anchorage, AK 99507

Port MacKenzie
ATTN: Marc VanDongen
Matanuska-Susitna Borough
350 East Dahlia Ave
Palmer, AK 99645

Port of Anchorage
ATTN: William Sheffield
2000 Anchorage Port Rd.
Anchorage, AK 99501

Eagle River Community Council
ATTN: Michael Foster
13135 Old Glenn Hwy
Ste 200
Eagle River, AK 99577

Fairview Community Council
ATTN: Sharon Chamard
1121 E. 10th Ave.
Anchorage, AK 99501

Government Hill Community Council
ATTN: Bob French
P. O. Box 101677
Anchorage, AK 99510

Mountain View Community Council
ATTN: Don Crandall
P.O. Box 142824
Anchorage, AK 99514

Northeast Community Council
ATTN: Kevin Smestad
7600 Boundary Ave
Anchorage, AK 99504

Municipality of Anchorage
ATTN: Dan Sullivan
632 W. Sixth Ave.
Suite 840
Anchorage, AK 99501

Congressman Don Young
ATTN: Michael Anderson
2111 Rayburn House Office Building
Washington, DC 20515-0201

Congressman Don Young
ATTN: Chad Padgett
510 L Street
Suite 580
Anchorage, AK 99501

Senator Mark Begich
ATTN: Susanne Fleek
510 L Street
Suite 750
Anchorage, AK 99501

Senator Mark Begich
ATTN: David Ramseur
144 Russell Senate Office Building
Washington, DC 20510

Senator Lisa Murkowski
ATTN: Karen Knutson
709 Hart Senate Office Building
Washington, DC 20510-0202

Senator Lisa Murkowski
ATTN: Kevin Sweeney
510 L Street
Suite 550
Anchorage, AK 99501

State of Alaska
ATTN: Sean Parnell
PO Box 110001
Juneau, AK 99811-0001

Alaska Resources Library and Information Services
3211 Providence Dr.
Suite 111
Anchorage, AK 99508

Alaska State Court Law Library
303 K Street
Anchorage, AK 99501

Alaska State Library
P.O. Box 110571
Juneau, AK 99811

Delta Community Library
2291 Deborah St.
Delta Junction, AK 99737

Eagle Public Library
P.O. Box 45
Eagle, AK 99738

Fairbanks North Star Borough
Noel Wien Library
1215 Cowles St.
Fairbanks, AK 99701

Joint Base Elmendorf Richardson Library
123 Chilkoot Ave.
JBER, AK 99505

Lime Village School Library
P.O. Box LVD, Lime Village VIA
McGrath, AK, AK 99627

Martin Monsen Regional Library
P.O. Box 147
Naknek, AK 99633

Tanana Community and School Library
P.O. Box 109
Tanana, AK 99777

University of Alaska Fairbanks
Elmer E. Rasmuson Library
P.O. Box 756811
Fairbanks, AK 99775

Wasilla Public Library
391 N. Main St.
Wasilla, AK 99654

F-22 Plus-Up Environmental Assessment
Joint Base Elmendorf-Richardson, Alaska
Alaska Native Villages
EA Memorandum Distribution List

Native Village of Cantwell
ATTN: Veronica Nicholas
P.O. Box 94
Cantwell, AK 99729

Chalkyitsik Village
ATTN: William Salmon, Jr.
PO Box 57
Chalkyitsik, AK 99788

ATTN: Gary Harrison
Chickaloon Native Village
PO Box 1105
Chickaloon, AK 99647

Circle Native Community (IRA)
ATTN: Larry Nathaniel
PO Box 89
Circle, AK 99733

Native Village of Crooked Creek
ATTN: Evelyn Thomas
P.O. Box 69
Crooked Creek, AK 99575

Village of Dot Lake
ATTN: William Miller
PO Box 2279
Dot Lake, AK 99737

Native Village of Eagle (IRA)
ATTN: Conan Goebel
PO Box 19
Eagle, AK 99738

Eklutna Native Village
ATTN: Dorothy Cook
26339 Eklutna Village Road
Chugiak, AK 99567

Gwichyaa Zhee Gwich'in Tribal Govt. (Native Village of Fort Yukon (IRA))
ATTN: Michael Peter
P.O. Box 126
Fort Yukon, AK 99740-0126

Healy Lake Village
ATTN: JoAnn Polston
PO Box 74090
Fairbanks, AK 99706

Igiugig Village
ATTN: AlexAnna Salmon
P.O. Box 4008
Igiugig, AK 99613-4008

Village of Iliamna
ATTN: Harvey Anelon
P.O. Box 286
Iliamna, AK 99606

Kaltag Tribal Council
ATTN: Donna Esmailka
P.O. Box 129
Kaltag, AK 99748

King Salmon Tribe
ATTN: Ralph Angasan, Sr
P.O. Box 68
King Salmon, AK 99613-0068

Knik Village
ATTN: Debra Call
PO Box 871565
Wasilla, AK 99687

Kokhanok Village
ATTN: John Nelson
P.O. Box 1007
Kokhanok, AK 99606

Lime Village Traditional Council
ATTN: Jennifer John
P.O. Box LVD, Lime Village VIA
McGrath, AK, AK 99627

Louden Tribal Council
ATTN: Chris Sommer
100 Tiger Hwy.
Galena, AK 99741

McGrath Native Village Council
ATTN: Carolyn Vanderpool
P.O. Box 134
McGrath, AK 99627

Naknek Native Village
ATTN: Patrick Peterson, Jr.
P.O. Box 106
Naknek, AK 99633

Nenana Native Association
ATTN: William Lord
P.O. Box 356
Nenana, AK 99760

New Koliganek Village Council
ATTN: Herman Nelson, Sr.
P.O. Box 5057
Koliganek, AK 99576

New Stuyahok Village
ATTN: Evan Wonhda
P.O. Box 49
New Stuyahok, AK 99636

Newhalen Village
ATTN: Raymond Wassillie
P.O. Box 207
Newhalen, AK 99606

Nondalton Village
ATTN: Jack Hobson
P.O. Box 49
Nondalton, AK 99640

Pedro Bay Village Council
ATTN: Keith Jensen
P.O. Box 47020
Pedro Bay, AK 99647

Red Devil Traditional Council
ATTN: Mary Willis
P.O. Box 61
Red Devil, AK 99656

Ruby Tribal Council
ATTN: Patrick McCarty
P.O. Box 210
Ruby, AK 99768

Sleetmute Traditional Council
ATTN: Pete Mellick
P.O. Box 109
Sleetmute, AK 99668

Village of Stony River
ATTN: Mary Willis
P.O. Box SRV
Stony River, AK 99557

Tanacross Village Council
ATTN: Roy Danny
P.O. Box 76009
Tanacross, AK 99776

Native Village of Tanana (IRA)
ATTN: Julia Roberts-Hyslop
P.O. Box 130
Tanana, AK 99777

Native Village of Tyonek
ATTN: Angela Sandstol
PO Box 82009
Tyonek, AK 99682

Native Village of Venetie Tribal Government (IRA)
ATTN: Julian Roberts
P.O. Box 81080
Venetie, AK 99781

Venetie Village Council
ATTN: Mary Gamboa
P.O. Box 81119
Venetie, AK 99781

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673D AIR BASE WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

12 April 2011

MEMORANDUM FOR SEE DISTRIBUTION

FROM: 673 CES/CC
6326 Arctic Warrior Drive
Joint Base Elmendorf-Richardson AK 99506-3240

SUBJECT: Environmental Assessment for the Plus-Up of Seven Additional F-22 Aircraft at Joint Base Elmendorf-Richardson, Alaska

1. The 673d Air Base Wing (ABW) and the United States Air Force (USAF) are pleased to provide you a copy of the Environmental Assessment (EA) and Draft Finding of No Significant Impact (FONSI) for the proposed addition (plus-up) of seven F-22 aircraft to the Joint Base Elmendorf-Richardson (JBER) current inventory of 40 F-22 aircraft. The additional aircraft would train in existing Alaska airspace and would not require construction of any new facilities.

2. You are invited to provide comments on the proposed action by mail, postmarked no later than May 12, 2011, to ensure proper consideration in the preparation of the EA. Please send any comments to:

Mr. Bob Hall
673 ABW/PA
10480 22nd St.
Joint Base Elmendorf-Richardson AK 99506-3240

3. Written comments received by the Air Force will be considered in the preparation of the EA and will be made a part of the administrative record. Thank you for your participation.

4. Please direct any written comments or requests for information to Mr. Bob Hall at (907) 552-8152.

J. DAVID NORTON, Lt Col, USAF
Commander

Attachments:
1. Environmental Assessment
2. Distribution List

F-22 Plus-Up Environmental Assessment
Joint Base Elmendorf-Richardson, Alaska
Agency Coordination
EA Memorandum Distribution List

Federal Aviation Administration, Alaska Region
ATTN: Bob Lewis
222 West 7th Ave. #14
Anchorage, AK 99513

U.S. Department of Agriculture
ATTN: Robert Jones
Natural Resources Conservation Service
800 W. Evergreen Ave., Suite 100
Palmer, AK 99545-6539

U.S. Department of Interior
ATTN: Pamela Bergmann
Office of Environmental Policy
1689 C Street, Rm. 119
Anchorage, AK 99501

U.S. Department of Transportation
ATTN: David Miller
Federal Highway Administration
P.O. Box 21648
Juneau, AK 99802-1648

U.S. Department of Transportation
ATTN: Robert Bouchard
Maritime Administration
1200 New Jersey Ave., SE (mar-510,#w21-224
Washington, DC 20590

U.S. Department of Interior
ATTN: Edward Parisian
Bureau of Indian Affairs, Alaska Regional Office
P.O. Box 25520
Juneau, AK 99802

U.S. Department of Transportation
ATTN: Richard Krochalis
Federal Transit Administration, Regional 10
915 Second Ave., Ste. 3142
Seattle, WA 98174-1002

U.S. Fish and Wildlife Service
ATTN: Ann Rappoport
Anchorage Fish & Wildlife Field Office
605 4th Ave., Rm. G-61
Anchorage, AK 99501

United States Coast Guard
ATTN: CAPT Jason Fosdick
Sector Anchorage
510 L Street, Ste. 100
Anchorage, AK 99501

National Marine Fisheries Service
ATTN: Brad Smith
Protected Resources Div/Habitat Consrv
222 W. 7th Avenue, Rm. 517
Anchorage, AK 99513

National Park Service
ATTN: Sue Masica
Alaska Regional Office
240 W 5th Avenue, Room 114
Anchorage, AK 99501

Bureau of Land Management
ATTN: Gary Reimer
Anchorage District Office
4700 BLM Rd.
Anchorage, AK 99507

U.S. Environmental Protection Agency, Region 10
ATTN: Jacques Gusmano
222 West 7th Ave.
Room 537
Anchorage, AK 99513-7588

Alaska Department of Environmental Conservation
ATTN: Deb Caillouet
555 Cordova
Anchorage, AK 99501

Alaska Department of Fish and Game
ATTN: Mark Burch
Division of Wildlife Conservation
333 Raspberry Rd.
Anchorage, AK 99518-1599

Alaska Department of Military and Veterans Affairs
ATTN: MAJ GEN Thomas Katkus
PO Box 5800
Camp Denali
JBER, AK 99505

Alaska Department of Natural Resources
ATTN: Thomas Irwin
Office of the Commissioner
550 W. 7th Avenue, Suite 1400
Anchorage, AK 99501

Alaska Department of Natural Resources
ATTN: Judith Bittner
Office of History and Archaeology
550 W 7th Avenue, Ste. 1310
Anchorage, AK 99501

Alaska Department of Natural Resources
ATTN: James King
Parks and Outdoor Recreation
550 W. 7th Ave., Ste 1380
Anchorage, AK 99501-3561

Alaska Department of Transportation
ATTN: Lance Wilbur, AICP
Central Region
4111 Aviation Ave.
Anchorage, AK 99501

Alaska Railroad Corporation
ATTN: Christopher Aadnesen
P.O. Box 107500
Anchorage, AK 99510

Ted Stevens Anchorage International Airport
ATTN: John Parrot
PO Box 196960
Anchorage, AK 99519

Anchorage Assembly
ATTN: Barbara Gruenstein
P.O. Box 196650
Anchorage, AK 99519

Municipality of Anchorage
ATTN: Debbie Sedwick
Anchorage Community Development Authority
245 W. 5th Ave., Ste. 122
Anchorage, AK 99501

Municipality of Anchorage
ATTN: Greg Jones
Community Planning & Development
4700 Elmore Road
Anchorage, AK 99507

Port MacKenzie
ATTN: Marc VanDongen
Matanuska-Susitna Borough
350 East Dahlia Ave
Palmer, AK 99645

Port of Anchorage
ATTN: William Sheffield
2000 Anchorage Port Rd.
Anchorage, AK 99501

Eagle River Community Council
ATTN: Michael Foster
13135 Old Glenn Hwy
Ste 200
Eagle River, AK 99577

Fairview Community Council
ATTN: Sharon Chamard
1121 E. 10th Ave.
Anchorage, AK 99501

Government Hill Community Council
ATTN: Bob French
P. O. Box 101677
Anchorage, AK 99510

Mountain View Community Council
ATTN: Don Crandall
P.O. Box 142824
Anchorage, AK 99514

Northeast Community Council
ATTN: Kevin Smestad
7600 Boundary Ave
Anchorage, AK 99504

Municipality of Anchorage
ATTN: Dan Sullivan
632 W. Sixth Ave.
Suite 840
Anchorage, AK 99501

Congressman Don Young
ATTN: Michael Anderson
2111 Rayburn House Office Building
Washington, DC 20515-0201

Congressman Don Young
ATTN: Chad Padgett
510 L Street
Suite 580
Anchorage, AK 99501

Senator Mark Begich
ATTN: Susanne Fleek
510 L Street
Suite 750
Anchorage, AK 99501

Senator Mark Begich
ATTN: David Ramseur
144 Russell Senate Office Building
Washington, DC 20510

Senator Lisa Murkowski
ATTN: Karen Knutson
709 Hart Senate Office Building
Washington, DC 20510-0202

Senator Lisa Murkowski
ATTN: Kevin Sweeney
510 L Street
Suite 550
Anchorage, AK 99501

State of Alaska
ATTN: Sean Parnell
PO Box 110001
Juneau, AK 99811-0001

Alaska Resources Library and Information Services
3211 Providence Dr.
Suite 111
Anchorage, AK 99508

Alaska State Court Law Library
303 K Street
Anchorage, AK 99501

Alaska State Library
P.O. Box 110571
Juneau, AK 99811

Delta Community Library
2291 Deborah St.
Delta Junction, AK 99737

Eagle Public Library
P.O. Box 45
Eagle, AK 99738

Fairbanks North Star Borough
Noel Wien Library
1215 Cowles St.
Fairbanks, AK 99701

Joint Base Elmendorf Richardson Library
123 Chilkoot Ave.
JBER, AK 99505

Lime Village School Library
P.O. Box LVD, Lime Village VIA
McGrath, AK, AK 99627

Martin Monsen Regional Library
P.O. Box 147
Naknek, AK 99633

Tanana Community and School Library
P.O. Box 109
Tanana, AK 99777

University of Alaska Fairbanks
Elmer E. Rasmuson Library
P.O. Box 756811
Fairbanks, AK 99775

Wasilla Public Library
391 N. Main St.
Wasilla, AK 99654

F-22 Plus-Up Environmental Assessment
Joint Base Elmendorf-Richardson, Alaska
Alaska Native Villages
EA Memorandum Distribution List

Native Village of Cantwell
ATTN: Veronica Nicholas
P.O. Box 94
Cantwell, AK 99729

Chalkyitsik Village
ATTN: William Salmon, Jr.
PO Box 57
Chalkyitsik, AK 99788

ATTN: Gary Harrison
Chickaloon Native Village
PO Box 1105
Chickaloon, AK 99647

Circle Native Community (IRA)
ATTN: Larry Nathaniel
PO Box 89
Circle, AK 99733

Native Village of Crooked Creek
ATTN: Evelyn Thomas
P.O. Box 69
Crooked Creek, AK 99575

Village of Dot Lake
ATTN: William Miller
PO Box 2279
Dot Lake, AK 99737

Native Village of Eagle (IRA)
ATTN: Conan Goebel
PO Box 19
Eagle, AK 99738

Eklutna Native Village
ATTN: Dorothy Cook
26339 Eklutna Village Road
Chugiak, AK 99567

Gwichyaa Zhee Gwich'in Tribal Govt. (Native Village of Fort Yukon (IRA))
ATTN: Michael Peter
P.O. Box 126
Fort Yukon, AK 99740-0126

Healy Lake Village
ATTN: JoAnn Polston
PO Box 74090
Fairbanks, AK 99706

Igiugig Village
ATTN: AlexAnna Salmon
P.O. Box 4008
Igiugig, AK 99613-4008

Village of Iliamna
ATTN: Harvey Anelon
P.O. Box 286
Iliamna, AK 99606

Kaltag Tribal Council
ATTN: Donna Esmailka
P.O. Box 129
Kaltag, AK 99748

King Salmon Tribe
ATTN: Ralph Angasan, Sr
P.O. Box 68
King Salmon, AK 99613-0068

Knik Village
ATTN: Debra Call
PO Box 871565
Wasilla, AK 99687

Kokhanok Village
ATTN: John Nelson
P.O. Box 1007
Kokhanok, AK 99606

Lime Village Traditional Council
ATTN: Jennifer John
P.O. Box LVD, Lime Village VIA
McGrath, AK, AK 99627

Louden Tribal Council
ATTN: Chris Sommer
100 Tiger Hwy.
Galena, AK 99741

McGrath Native Village Council
ATTN: Carolyn Vanderpool
P.O. Box 134
McGrath, AK 99627

Naknek Native Village
ATTN: Patrick Peterson, Jr.
P.O. Box 106
Naknek, AK 99633

Nenana Native Association
ATTN: William Lord
P.O. Box 356
Nenana, AK 99760

New Koliganek Village Council
ATTN: Herman Nelson, Sr.
P.O. Box 5057
Koliganek, AK 99576

New Stuyahok Village
ATTN: Evan Wonhda
P.O. Box 49
New Stuyahok, AK 99636

Newhalen Village
ATTN: Raymond Wassillie
P.O. Box 207
Newhalen, AK 99606

Nondalton Village
ATTN: Jack Hobson
P.O. Box 49
Nondalton, AK 99640

Pedro Bay Village Council
ATTN: Keith Jensen
P.O. Box 47020
Pedro Bay, AK 99647

Red Devil Traditional Council
ATTN: Mary Willis
P.O. Box 61
Red Devil, AK 99656

Ruby Tribal Council
ATTN: Patrick McCarty
P.O. Box 210
Ruby, AK 99768

Sleetmute Traditional Council
ATTN: Pete Mellick
P.O. Box 109
Sleetmute, AK 99668

Village of Stony River
ATTN: Mary Willis
P.O. Box SRV
Stony River, AK 99557

Tanacross Village Council
ATTN: Roy Danny
P.O. Box 76009
Tanacross, AK 99776

Native Village of Tanana (IRA)
ATTN: Julia Roberts-Hyslop
P.O. Box 130
Tanana, AK 99777

Native Village of Tyonek
ATTN: Angela Sandstol
PO Box 82009
Tyonek, AK 99682

Native Village of Venetie Tribal Government (IRA)
ATTN: Julian Roberts
P.O. Box 81080
Venetie, AK 99781

Venetie Village Council
ATTN: Mary Gamboa
P.O. Box 81119
Venetie, AK 99781

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673D AIR BASE WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

12 April 2011

MEMORANDUM FOR SLEETMUTE TRADITIONAL COUNCIL
ATTENTION: PETE MELLICK

FROM: 673 CES/CC
6326 Arctic Warrior Drive
Joint Base Elmendorf-Richardson AK 99506-3240

SUBJECT: Environmental Assessment for the Plus-Up of Seven Additional F-22 Aircraft at Joint Base Elmendorf-Richardson, Alaska

1. The 673d Air Base Wing (ABW) and the United States Air Force (USAF) are pleased to provide you a copy of the Environmental Assessment (EA) and Draft Finding of No Significant Impact (FONSI) for the proposed addition (plus-up) of seven F-22 aircraft to the Joint Base Elmendorf-Richardson (JBER) current inventory of 40 F-22 aircraft. The additional aircraft would train in existing Alaska airspace and would not require construction of any new facilities.

2. We received your response post card to our scoping process in December, 2010 with the comment that you had specific comments on the proposed project, but we did not receive your comments in January, 2011. We invite you to share them with us during this final comment period.

2. You are invited to provide comments on the proposed action by mail, postmarked no later than May 12, 2011, to ensure proper consideration in the preparation of the EA. Please send any comments to:

Mr. Bob Hall
673 ABW/PA
10480 22nd St.
Joint Base Elmendorf-Richardson AK 99506-3240

3. Written comments received by the Air Force will be considered in the preparation of the EA and will be made a part of the administrative record. Thank you for your participation.

4. Please direct any written comments or requests for information to Mr. Bob Hall at (907) 552-8152.

J. DAVID NORTON, Lt Col, USAF
Commander

Attachments:
Environmental Assessment

F-22 Plus-Up Environmental Assessment
Joint Base Elmendorf-Richardson, Alaska
Agency Coordination
EA Memorandum Distribution List

Federal Aviation Administration, Alaska Region
ATTN: Bob Lewis
222 West 7th Ave. #14
Anchorage, AK 99513

U.S. Department of Agriculture
ATTN: Robert Jones
Natural Resources Conservation Service
800 W. Evergreen Ave., Suite 100
Palmer, AK 99545-6539

U.S. Department of Interior
ATTN: Pamela Bergmann
Office of Environmental Policy
1689 C Street, Rm. 119
Anchorage, AK 99501

U.S. Department of Transportation
ATTN: David Miller
Federal Highway Administration
P.O. Box 21648
Juneau, AK 99802-1648

U.S. Department of Transportation
ATTN: Robert Bouchard
Maritime Administration
1200 New Jersey Ave., SE (mar-510,#w21-224
Washington, DC 20590

U.S. Department of Interior
ATTN: Edward Parisian
Bureau of Indian Affairs, Alaska Regional Office
P.O. Box 25520
Juneau, AK 99802

U.S. Department of Transportation
ATTN: Richard Krochalis
Federal Transit Administration, Regional 10
915 Second Ave., Ste. 3142
Seattle, WA 98174-1002

U.S. Fish and Wildlife Service
ATTN: Ann Rappoport
Anchorage Fish & Wildlife Field Office
605 4th Ave., Rm. G-61
Anchorage, AK 99501

United States Coast Guard
ATTN: CAPT Jason Fosdick
Sector Anchorage
510 L Street, Ste. 100
Anchorage, AK 99501

National Marine Fisheries Service
ATTN: Brad Smith
Protected Resources Div/Habitat Consrv
222 W. 7th Avenue, Rm. 517
Anchorage, AK 99513

National Park Service
ATTN: Sue Masica
Alaska Regional Office
240 W 5th Avenue, Room 114
Anchorage, AK 99501

Bureau of Land Management
ATTN: Gary Reimer
Anchorage District Office
4700 BLM Rd.
Anchorage, AK 99507

U.S. Environmental Protection Agency, Region 10
ATTN: Jacques Gusmano
222 West 7th Ave.
Room 537
Anchorage, AK 99513-7588

Alaska Department of Environmental Conservation
ATTN: Deb Caillouet
555 Cordova
Anchorage, AK 99501

Alaska Department of Fish and Game
ATTN: Mark Burch
Division of Wildlife Conservation
333 Raspberry Rd.
Anchorage, AK 99518-1599

Alaska Department of Military and Veterans Affairs
ATTN: MAJ GEN Thomas Katkus
PO Box 5800
Camp Denali
JBER, AK 99505

Alaska Department of Natural Resources
ATTN: Thomas Irwin
Office of the Commissioner
550 W. 7th Avenue, Suite 1400
Anchorage, AK 99501

Alaska Department of Natural Resources
ATTN: Judith Bittner
Office of History and Archaeology
550 W 7th Avenue, Ste. 1310
Anchorage, AK 99501

Alaska Department of Natural Resources
ATTN: James King
Parks and Outdoor Recreation
550 W. 7th Ave., Ste 1380
Anchorage, AK 99501-3561

Alaska Department of Transportation
ATTN: Lance Wilbur, AICP
Central Region
4111 Aviation Ave.
Anchorage, AK 99501

Alaska Railroad Corporation
ATTN: Christopher Aadnesen
P.O. Box 107500
Anchorage, AK 99510

Ted Stevens Anchorage International Airport
ATTN: John Parrot
PO Box 196960
Anchorage, AK 99519

Anchorage Assembly
ATTN: Barbara Gruenstein
P.O. Box 196650
Anchorage, AK 99519

Municipality of Anchorage
ATTN: Debbie Sedwick
Anchorage Community Development Authority
245 W. 5th Ave., Ste. 122
Anchorage, AK 99501

Municipality of Anchorage
ATTN: Greg Jones
Community Planning & Development
4700 Elmore Road
Anchorage, AK 99507

Port MacKenzie
ATTN: Marc VanDongen
Matanuska-Susitna Borough
350 East Dahlia Ave
Palmer, AK 99645

Port of Anchorage
ATTN: William Sheffield
2000 Anchorage Port Rd.
Anchorage, AK 99501

Eagle River Community Council
ATTN: Michael Foster
13135 Old Glenn Hwy
Ste 200
Eagle River, AK 99577

Fairview Community Council
ATTN: Sharon Chamard
1121 E. 10th Ave.
Anchorage, AK 99501

Government Hill Community Council
ATTN: Bob French
P. O. Box 101677
Anchorage, AK 99510

Mountain View Community Council
ATTN: Don Crandall
P.O. Box 142824
Anchorage, AK 99514

Northeast Community Council
ATTN: Kevin Smestad
7600 Boundary Ave
Anchorage, AK 99504

Municipality of Anchorage
ATTN: Dan Sullivan
632 W. Sixth Ave.
Suite 840
Anchorage, AK 99501

Congressman Don Young
ATTN: Michael Anderson
2111 Rayburn House Office Building
Washington, DC 20515-0201

Congressman Don Young
ATTN: Chad Padgett
510 L Street
Suite 580
Anchorage, AK 99501

Senator Mark Begich
ATTN: Susanne Fleek
510 L Street
Suite 750
Anchorage, AK 99501

Senator Mark Begich
ATTN: David Ramseur
144 Russell Senate Office Building
Washington, DC 20510

Senator Lisa Murkowski
ATTN: Karen Knutson
709 Hart Senate Office Building
Washington, DC 20510-0202

Senator Lisa Murkowski
ATTN: Kevin Sweeney
510 L Street
Suite 550
Anchorage, AK 99501

State of Alaska
ATTN: Sean Parnell
PO Box 110001
Juneau, AK 99811-0001

Alaska Resources Library and Information Services
3211 Providence Dr.
Suite 111
Anchorage, AK 99508

Alaska State Court Law Library
303 K Street
Anchorage, AK 99501

Alaska State Library
P.O. Box 110571
Juneau, AK 99811

Delta Community Library
2291 Deborah St.
Delta Junction, AK 99737

Eagle Public Library
P.O. Box 45
Eagle, AK 99738

Fairbanks North Star Borough
Noel Wien Library
1215 Cowles St.
Fairbanks, AK 99701

Joint Base Elmendorf Richardson Library
123 Chilkoot Ave.
JBER, AK 99505

Lime Village School Library
P.O. Box LVD, Lime Village VIA
McGrath, AK, AK 99627

Martin Monsen Regional Library
P.O. Box 147
Naknek, AK 99633

Tanana Community and School Library
P.O. Box 109
Tanana, AK 99777

University of Alaska Fairbanks
Elmer E. Rasmuson Library
P.O. Box 756811
Fairbanks, AK 99775

Wasilla Public Library
391 N. Main St.
Wasilla, AK 99654

F-22 Plus-Up Environmental Assessment
Joint Base Elmendorf-Richardson, Alaska
Alaska Native Villages
EA Memorandum Distribution List

Native Village of Cantwell
ATTN: Veronica Nicholas
P.O. Box 94
Cantwell, AK 99729

Chalkyitsik Village
ATTN: William Salmon, Jr.
PO Box 57
Chalkyitsik, AK 99788

ATTN: Gary Harrison
Chickaloon Native Village
PO Box 1105
Chickaloon, AK 99647

Circle Native Community (IRA)
ATTN: Larry Nathaniel
PO Box 89
Circle, AK 99733

Native Village of Crooked Creek
ATTN: Evelyn Thomas
P.O. Box 69
Crooked Creek, AK 99575

Village of Dot Lake
ATTN: William Miller
PO Box 2279
Dot Lake, AK 99737

Native Village of Eagle (IRA)
ATTN: Conan Goebel
PO Box 19
Eagle, AK 99738

Eklutna Native Village
ATTN: Dorothy Cook
26339 Eklutna Village Road
Chugiak, AK 99567

Gwichyaa Zhee Gwich'in Tribal Govt. (Native Village of Fort Yukon (IRA))
ATTN: Michael Peter
P.O. Box 126
Fort Yukon, AK 99740-0126

Healy Lake Village
ATTN: JoAnn Polston
PO Box 74090
Fairbanks, AK 99706

Igiugig Village
ATTN: AlexAnna Salmon
P.O. Box 4008
Igiugig, AK 99613-4008

Village of Iliamna
ATTN: Harvey Anelon
P.O. Box 286
Iliamna, AK 99606

Kaltag Tribal Council
ATTN: Donna Esmailka
P.O. Box 129
Kaltag, AK 99748

King Salmon Tribe
ATTN: Ralph Angasan, Sr
P.O. Box 68
King Salmon, AK 99613-0068

Knik Village
ATTN: Debra Call
PO Box 871565
Wasilla, AK 99687

Kokhanok Village
ATTN: John Nelson
P.O. Box 1007
Kokhanok, AK 99606

Lime Village Traditional Council
ATTN: Jennifer John
P.O. Box LVD, Lime Village VIA
McGrath, AK, AK 99627

Louden Tribal Council
ATTN: Chris Sommer
100 Tiger Hwy.
Galena, AK 99741

McGrath Native Village Council
ATTN: Carolyn Vanderpool
P.O. Box 134
McGrath, AK 99627

Naknek Native Village
ATTN: Patrick Peterson, Jr.
P.O. Box 106
Naknek, AK 99633

Nenana Native Association
ATTN: William Lord
P.O. Box 356
Nenana, AK 99760

New Koliganek Village Council
ATTN: Herman Nelson, Sr.
P.O. Box 5057
Koliganek, AK 99576

New Stuyahok Village
ATTN: Evan Wonhda
P.O. Box 49
New Stuyahok, AK 99636

Newhalen Village
ATTN: Raymond Wassillie
P.O. Box 207
Newhalen, AK 99606

Nondalton Village
ATTN: Jack Hobson
P.O. Box 49
Nondalton, AK 99640

Pedro Bay Village Council
ATTN: Keith Jensen
P.O. Box 47020
Pedro Bay, AK 99647

Red Devil Traditional Council
ATTN: Mary Willis
P.O. Box 61
Red Devil, AK 99656

Ruby Tribal Council
ATTN: Patrick McCarty
P.O. Box 210
Ruby, AK 99768

Sleetmute Traditional Council
ATTN: Pete Mellick
P.O. Box 109
Sleetmute, AK 99668

Village of Stony River
ATTN: Mary Willis
P.O. Box SRV
Stony River, AK 99557

Tanacross Village Council
ATTN: Roy Danny
P.O. Box 76009
Tanacross, AK 99776

Native Village of Tanana (IRA)
ATTN: Julia Roberts-Hyslop
P.O. Box 130
Tanana, AK 99777

Native Village of Tyonek
ATTN: Angela Sandstol
PO Box 82009
Tyonek, AK 99682

Native Village of Venetie Tribal Government (IRA)
ATTN: Julian Roberts
P.O. Box 81080
Venetie, AK 99781

Venetie Village Council
ATTN: Mary Gamboa
P.O. Box 81119
Venetie, AK 99781

Appendix D

Aircraft Noise Analysis and Airspace Operations

This page intentionally left blank.

APPENDIX D AIRCRAFT NOISE ANALYSIS AND AIRSPACE OPERATIONS

Noise is generally described as unwanted sound. Unwanted sound can be based on objective effects (such as hearing loss or damage to structures) or subjective judgments (community annoyance). Noise analysis thus requires a combination of physical measurement of sound, physical and physiological effects, plus psycho- and socio-acoustic effects.

Section 1.0 of this appendix describes how sound is measured and summarizes noise impact in terms of community acceptability and land use compatibility. Section 2.0 gives detailed descriptions of the effects of noise that lead to the impact guidelines presented in section 1. Section 3.0 provides a description of the specific methods used to predict aircraft noise, including a detailed description of sonic booms.

D1 Noise Descriptors and Impact

Aircraft operating in the Military Operations Areas (MOAs) and Warning Areas generate two types of sound. One is "subsonic" noise, which is continuous sound generated by the aircraft's engines and also by air flowing over the aircraft itself. The other is sonic booms (only in MOAs and Warning Areas authorized for supersonic), which are transient impulsive sounds generated during supersonic flight. These are quantified in different ways.

Section 1.1 describes the characteristics which are used to describe sound. Section 1.2 describes the specific noise metrics used for noise impact analysis. Section 1.3 describes how environmental impact and land use compatibility are judged in terms of these quantities.

D1.1 Quantifying Sound

Measurement and perception of sound involve two basic physical characteristics: amplitude and frequency. Amplitude is a measure of the strength of the sound and is directly measured in terms of the pressure of a sound wave. Because sound pressure varies in time, various types of pressure averages are usually used. Frequency, commonly perceived as pitch, is the number of times per second the sound causes air molecules to oscillate. Frequency is measured in units of cycles per second, or hertz (Hz).

Amplitude. The loudest sounds the human ear can comfortably hear have acoustic energy one trillion times the acoustic energy of sounds the ear can barely detect. Because of this vast range, attempts to represent sound amplitude by pressure are generally unwieldy. Sound is, therefore, usually represented on a logarithmic scale with a unit called the decibel (dB). Sound on the decibel scale is referred to as a sound level. The threshold of human hearing is approximately 0 dB, and the threshold of discomfort or pain is around 120 dB.

Because of the logarithmic nature of the decibel scale, sounds levels do not add and subtract directly and are somewhat cumbersome to handle mathematically. However, some simple rules of thumb are useful in dealing with sound levels. First, if a sound's intensity is doubled, the sound level increases by 3 dB, regardless of the initial sound level. Thus, for example:

60 dB + 60 dB = 63 dB, and

80 dB + 80 dB = 83 dB.

The total sound level produced by two sounds of different levels is usually only slightly more than the higher of the two. For example:

60.0 dB + 70.0 dB = 70.4 dB.

Because the addition of sound levels behaves differently than that of ordinary numbers, such addition is often referred to as "decibel addition" or "energy addition." The latter term arises from the fact that combination of decibel values consists of first converting each decibel value to its corresponding acoustic energy, then adding the energies using the normal rules of addition, and finally converting the total energy back to its decibel equivalent.

The difference in dB between two sounds represents the ratio of the amplitudes of those two sounds. Because human senses tend to be proportional (i.e., detect whether one sound is twice as big as another) rather than absolute (i.e., detect whether one sound is a given number of pressure units bigger than another), the decibel scale correlates well with human response.

Under laboratory conditions, differences in sound level of 1 dB can be detected by the human ear. In the community, the smallest change in average noise level that can be detected is about 3 dB. A change in sound level of about 10 dB is usually perceived by the average person as a doubling (or halving) of the sound's loudness, and this relation holds true for loud sounds and for quieter sounds. A decrease in sound level of 10 dB actually represents a 90 percent decrease in sound *intensity* but only a 50 percent decrease in perceived *loudness* because of the nonlinear response of the human ear (similar to most human senses).

The one exception to the exclusive use of levels, rather than physical pressure units, to quantify sound is in the case of sonic booms. As described in Section 3, sonic booms are coherent waves with specific characteristics. There is a long-standing tradition of describing individual sonic booms by the amplitude of the shock waves, in pounds per square foot (psf). This is particularly relevant when assessing structural effects as opposed to loudness or cumulative community response. In this study, sonic booms are quantified by either dB or psf, as appropriate for the particular impact being assessed.

Frequency. The normal human ear can hear frequencies from about 20 Hz to about 20,000 Hz. It is most sensitive to sounds in the 1,000 to 4,000 Hz range. When measuring community response to noise, it is common to adjust the frequency content of the measured sound to correspond to the frequency sensitivity of the human ear. This adjustment is called A-weighting (American National Standards Institute 1988). Sound levels that have been so adjusted are referred to as A-weighted sound levels.

The spectral content of the F-22A is somewhat different than other aircraft, including(at high throttle settings) the characteristic nonlinear crackle of high thrust engines. The spectral characteristics of various noises are accounted for by A-weighting, which approximates the response of the human ear. There are other, more detailed, weighting factors that have been applied to sounds. In the 1950s and 1960s, when noise from civilian jet aircraft became an issue, substantial research was performed to determine what characteristics of jet noise were a problem. The metrics Perceived Noise Level and Effective Perceived Noise Level were developed. These accounted for nonlinear behavior of hearing and the importance of low frequencies at high levels, and for many years airport/airbase noise contours were presented in terms of Noise Exposure Forecast, which was based on Perceived Noise Level and Effective Perceived Noise Level. In the 1970s, however, it was realized that the primary intrusive aspect of aircraft noise was the high noise level, a factor which is well represented by A-weighted levels and L_{dn}. The refinement of Perceived Noise Level, Effective Perceived Noise Level, and Noise Exposure Forecast was not significant in protecting the public from noise.

There has been continuing research on noise metrics and the importance of sound quality, sponsored by the Department of Defense (DoD) for military aircraft noise and by the Federal Aviation Administration (FAA) for civil aircraft noise. The metric L_{dnmr}, which accounts for the increased annoyance of rapid onset rate of sound, is a product of this long-term research. DoD is sponsoring the development of NoiseRunner, which will calculate noise in a more sophisticated manner than done by NOISEMAP and MR_NMAP. At the present time, however, NOISEMAP and MR_NMAP, and the metrics L_{dn} and L_{dnmr}, represent the best current science for analysis of military aircraft.

The amplitude of A-weighted sound levels is measured in dB. It is common for some noise analysts to denote the unit of A-weighted sounds by dBA. As long as the use of A-weighting is understood, there is no difference between dB or dBA: it is only important that the use of A-weighting be made clear. In this Environmental Assessment (EA), sound levels are reported in dB and are A-weighted unless otherwise specified.

A-weighting is appropriate for continuous sounds, which are perceived by the ear. Impulsive sounds, such as sonic booms, are perceived by more than just the ear. When experienced indoors, there can be secondary noise from rattling of the building. Vibrations may also be felt. C-weighting (American National Standards Institute 1988) is applied to such sounds. This is a frequency weighting that is flat over the range of human hearing (about 20 Hz to 20,000 Hz) and rolls off above and below that range. In this study, C-weighted sound levels are used for the assessment of sonic booms and other impulsive sounds. As with A-weighting, the unit is dB, but dBC is sometimes used for clarity. In this study, sound levels are reported in dB, and C-weighting is specified as necessary.

Time Averaging. Sound pressure of a continuous sound varies greatly with time, so it is customary to deal with sound levels that represent averages over time. Levels presented as instantaneous (i.e., as might be read from the dial of a sound level meter) are based on averages of sound energy over either 1/8 second (fast) or 1 second (slow). The formal definitions of fast and slow levels are somewhat complex, with details that are important to the makers and users of instrumentation. They may, however, be thought of as levels corresponding to the root-mean-square sound pressure measured over the 1/8-second or 1-second periods.

The most common uses of the fast or slow sound level in environmental analysis is in the discussion of the maximum sound level that occurs from the action, and in discussions of typical sound levels. Figure D-1 is a chart of A-weighted sound levels from typical sounds. Some (air conditioner, vacuum cleaner) are continuous sounds whose levels are constant for some time. Some (automobile, heavy truck) are the maximum sound during a vehicle passby. Some (urban daytime, urban nighttime) are averages over some extended period. A variety of noise metrics have been developed to describe noise over different time periods. These are described in section 1.2.

D1.1 Noise Metrics

D1.1.1 Maximum Sound Level

The highest A-weighted sound level measured during a single event in which the sound level changes value as time goes on (e.g., an aircraft overflight) is called the maximum A-weighted sound level or maximum sound level, for short. It is usually abbreviated by ALM, L_{max}, or L_{Amax}. The maximum sound level is important in judging the interference caused by a noise event with conversation, TV or radio listening, sleeping, or other common activities.

D1.1.2 Peak Sound Level

For impulsive sounds, the true instantaneous sound pressure is of interest. For sonic booms, this is the peak pressure of the shock wave, as described in section 3.2 of this appendix. This pressure is usually presented in physical units of pounds per square foot. Sometimes it is represented on the decibel scale, with symbol L_{pk}. Peak sound levels do not use either A or C weighting.

D1.1.3 Sound Exposure Level

Individual time-varying noise events have two main characteristics: a sound level that changes throughout the event and a period of time during which the event is heard. Although the maximum sound level, described above, provides some measure of the intrusiveness of the event, it alone does not completely describe the total event. The period of time during which the sound is heard is also significant. The Sound Exposure Level (abbreviated SEL or L_{AE} for A-weighted sounds) combines both of these characteristics into a single metric.

SEL is a composite metric that represents both the intensity of a sound and its duration. Mathematically, the mean square sound pressure is computed over the duration of the event, then multiplied by the duration in seconds, and the resultant product is turned into a sound level. It does not directly represent the sound level heard at any given time, but rather provides a measure of the net impact of the entire acoustic event. It has been well established in the scientific community that SEL measures this impact much more reliably than just the maximum sound level.

Because the SEL and the maximum sound level are both used to describe single events, there is sometimes confusion between the two, so the specific metric used should be clearly stated.

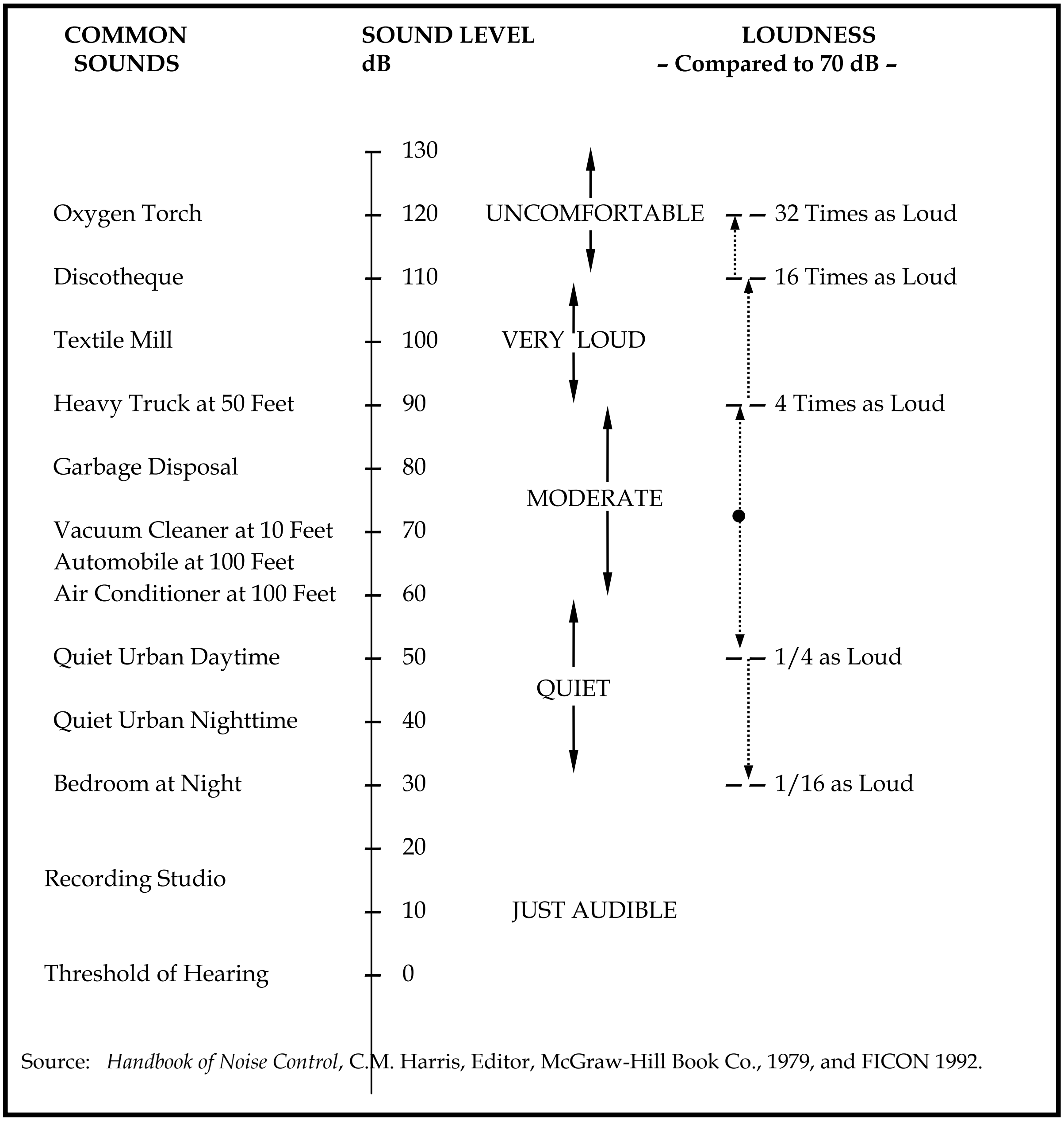


Figure D-1. Typical A-Weighted Sound Levels of Common Sounds

D1.1.4 Equivalent Sound Level

SEL can be computed for C-weighted levels (appropriate for impulsive sounds), and the results denoted CSEL or L_{CE}. SEL for A-weighted sound is sometimes denoted ASEL. Within this study, SEL is used for A-weighted sounds and CSEL for C-weighted.

For longer periods of time, total sound is represented by the equivalent continuous sound pressure level (L_{eq}). L_{eq} is the average sound level over some time period (often an hour or a day, but any explicit time span can be specified), with the averaging being done on the same energy basis as used for SEL. SEL and L_{eq} are closely related, differing by (a) whether they are applied over a specific time period or over an event, and (b) whether the duration of the event is included or divided out.

Just as SEL has proven to be a good measure of the noise impact of a single event, L_{eq} has been established to be a good measure of the impact of a series of events during a given time period. Also, while L_{eq} is defined as an average, it is effectively a sum over that time period and is, thus, a measure of the cumulative impact of noise.

D1.1.5 Day-Night Average Sound Level

Noise tends to be more intrusive at night than during the day. This effect is accounted for by applying a 10-dB penalty to events that occur after 10 pm and before 7 am. If L_{eq} is computed over a 24-hour period with this nighttime penalty applied, the result is the day-night average sound level (L_{dn}).

L_{dn} is the community noise metric recommended by the USEPA (United States Environmental Protection Agency [USEPA] 1974) and has been adopted by most federal agencies (Federal Interagency Committee on Noise 1992). It has been well established that L_{dn} correlates well with community response to noise (Schultz 1978; Finegold *et al.* 1994). This correlation is presented in Section 1.3 of this appendix. While L_{dn} carries the nomenclature "average," it incorporates all of the noise at a given location. For this reason, L_{dn} is often referred to as a "cumulative" metric. It accounts for the total, or cumulative, noise impact.

It was noted earlier that, for impulsive sounds, C-weighting is more appropriate than A-weighting. The day-night average sound level can be computed for C-weighted noise and is denoted CDNL or L_{Cdn}. This procedure has been standardized, and impact interpretive criteria similar to those for L_{dn} have been developed (Committee on Hearing, Bioacoustics and Biomechanics 1981).

D1.1.6 Onset-Adjusted Monthly Day-Night Average Sound Level

Aircraft operations in military airspace, such as MOAs and Warning Areas, generate a noise environment somewhat different from other community noise environments. Overflights are sporadic, occurring at random times and varying from day to day and week to week. This situation differs from most community noise environments, in which noise tends to be continuous or patterned. Individual military overflight events also differ from typical community noise events in that noise from a low-altitude, high-airspeed flyover can have a rather sudden onset.

To represent these differences, the conventional L_{dn} metric is adjusted to account for the "surprise" effect of the sudden onset of aircraft noise events on humans (Plotkin *et al.* 1987; Stusnick *et al.* 1992; Stusnick *et al.* 1993). For aircraft exhibiting a rate of increase in sound level (called onset rate) of from 15 to 150 dB per second, an adjustment or penalty ranging from 0 to 11 dB is added to the normal SEL. Onset rates above 150 dB per second require an 11 dB penalty, while onset rates below 15 dB per second require no adjustment. The L_{dn} is then determined in the same manner as for conventional aircraft noise events and is designated as Onset-Rate Adjusted Day-Night Average Sound Level (abbreviated L_{dnmr}). Because of the irregular occurrences of aircraft operations, the number of average daily operations is determined by using the calendar month with the highest number of operations. The monthly average is denoted L_{dnmr}. Noise levels are calculated the same way for both L_{dn} and L_{dnmr}. L_{dnmr} is interpreted by the same criteria as used for L_{dn}.

D1.2 Noise Impact

D1.2.1 Community Reaction

Studies of community annoyance to numerous types of environmental noise show that L_{dn} correlates well with impact. Schultz (1978) showed a consistent relationship between L_{dn} and annoyance. Shultz's original curve fit (Figure D-2) shows that there is a remarkable consistency in results of attitudinal surveys which relate the percentages of groups of people who express various degrees of annoyance when exposed to different L_{dn}.

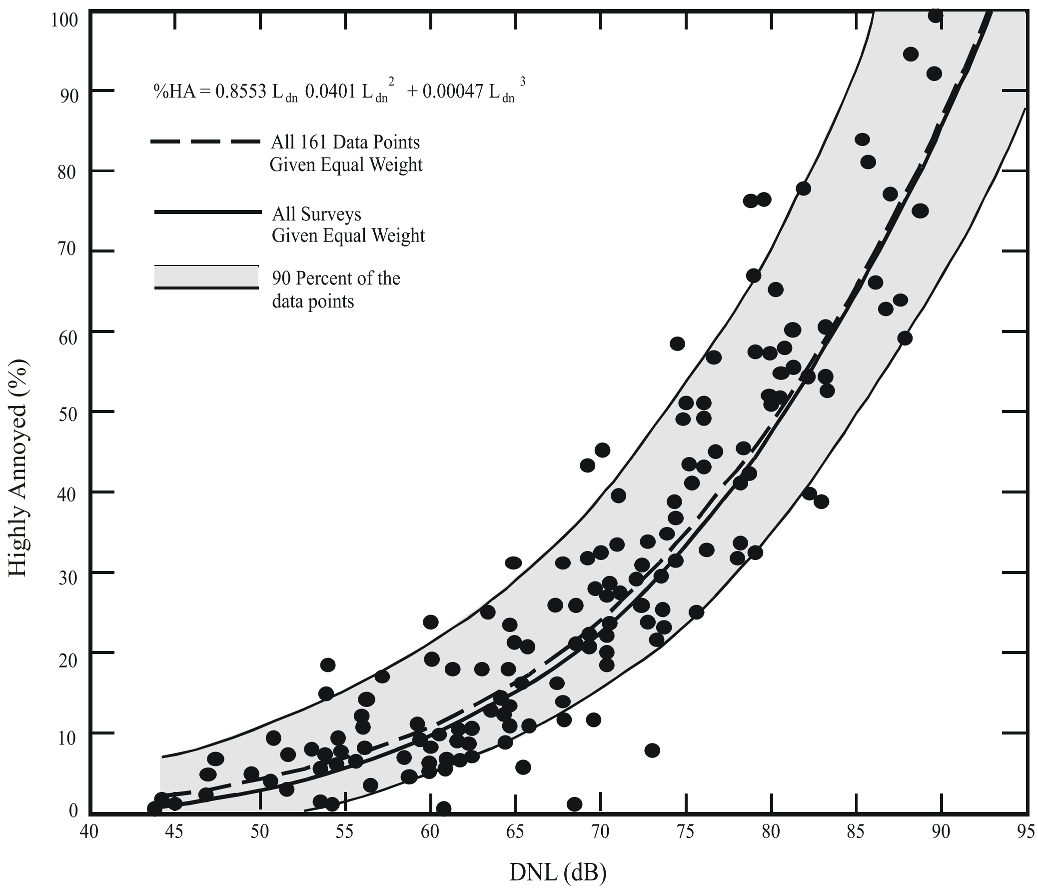
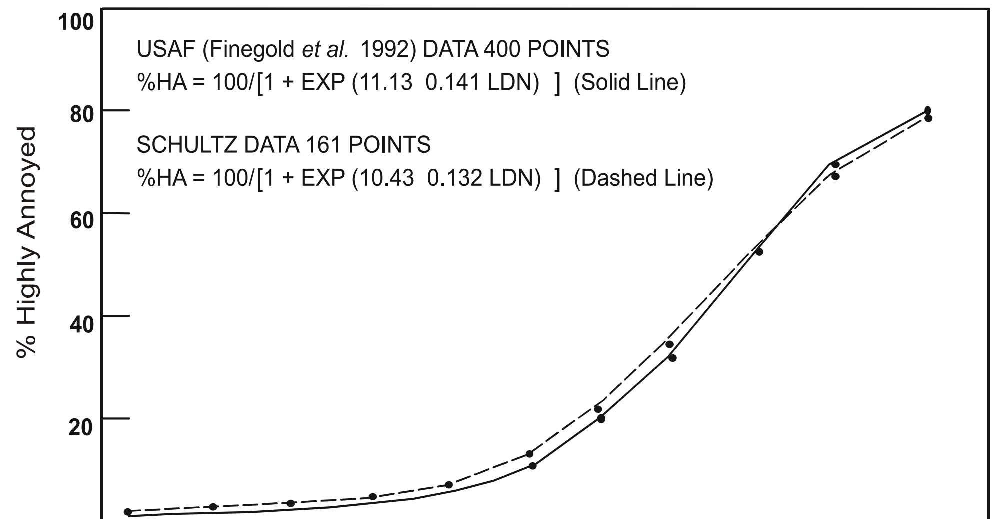


Figure D-2. Community Surveys of Noise Annoyance
(Source: Schultz 1978)

A more recent study has reaffirmed this relationship (Fidell *et al.* 1991). Figure D-3 (Federal Interagency Committee on Noise 1992) shows an updated form of the curve fit (Finegold *et al.* 1994) in comparison with the original. The updated fit, which does not differ substantially from the original, is the current preferred form. In general, correlation coefficients of 0.85 to 0.95 are found between the percentages of groups of people highly annoyed and the level of average noise exposure. The correlation coefficients for the annoyance of individuals are relatively low, however, on the order of 0.5 or less. This is not surprising, considering the varying personal factors that influence the manner in which individuals react to noise. Nevertheless, findings substantiate that community annoyance to aircraft noise is represented quite reliably using L_{dn}.



Day-Night Average Sound Level in dB		40	45	50	55	60	65	70	75	80	85	90
Calculated %HA Points	**USAF**	0.41	0.831	1.66	3.31	6.48	12.29	22.1	36.47	53.74	70.16	82.64
	SCHULTZ	0.576	1.11	2.12	4.03	7.52	13.59	23.32	37.05	53.25	68.78	81

Figure D-3. Response of Communities to Noise; Comparison of Original (Schultz 1978) and Current (Finegold et al. 1994) Curve Fits.

As noted earlier for SEL, L_{dn} does not represent the sound level heard at any particular time, but rather represents the total sound exposure. L_{dn} accounts for the sound level of individual noise events, the duration of those events, and the number of events. Its use is endorsed by the scientific community (American National Standards Institute 1980, 1988; USEPA 1974; Federal Interagency Committee on Urban Noise 1980; Federal Interagency Committee on Noise 1992).

While L_{dn} is the best metric for quantitatively assessing cumulative noise impact, it does not lend itself to intuitive interpretation by non-experts. Accordingly, it is common for environmental noise analyses to include other metrics for illustrative purposes. A general indication of the noise environment can be presented by noting the maximum sound levels which can occur and the number of times per day noise events will be loud enough to be heard. Use of other metrics as supplements to L_{dn} has been endorsed by federal agencies (Federal Interagency Committee on Noise 1992).

The Schultz curve is generally applied to annual average L_{dn}. In Section 1.2, L_{dnmr} was described and presented as being appropriate for quantifying noise in military airspace. In the current study, the Schultz curve is used with L_{dnmr} as the noise metric. L_{dnmr} is always equal to or greater than L_{dn}, so impact is generally higher than would have been predicted if the onset rate and busiest-month adjustments were not accounted for.

There are several points of interest in the noise-annoyance relation. The first is L_{dn} of 65 dB. This is a level most commonly used for noise planning purposes and represents a compromise between community impact and the need for activities like aviation which do cause noise.

Areas exposed to L_{dn} above 65 dB are generally not considered suitable for residential use. The second is L_{dn} of 55 dB, which was identified by USEPA as a level "...requisite to protect the public health and welfare with an adequate margin of safety," (USEPA 1974) which is essentially a level below which adverse impact is not expected.

The third is L_{dn} of 75 dB. This is the lowest level at which adverse health effects could be credible (USEPA 1974). The very high annoyance levels correlated with L_{dn} of 75 dB make such areas unsuitable for residential land use.

Sonic boom exposure is measured by C-weighting, with the corresponding cumulative metric being CDNL. Correlation between CDNL and annoyance has been established, based on community reaction to impulsive sounds (Committee on Hearing, Bioacoustics and Biomechanics 1981). Values of the C-weighted equivalent to the Schultz curve are different than that of the Schultz curve itself. Table D-1 shows the relation between annoyance, L_{dn}, and CDNL.

Table D-1. Relation Between Annoyance, L_{dn} and CDNL

CDNL	*% Highly Annoyed*	*L_{dn}*
48	2	50
52	4	55
57	8	60
61	14	65
65	23	70
69	35	75

Interpretation of CDNL from impulsive noise is accomplished by using the CDNL versus annoyance values in Table D-1. CDNL can be interpreted in terms of an "equivalent annoyance" L_{dn}. For example, CDNL of 52, 61, and 69 dB are equivalent to L_{dn} of 55, 65, and 75 dB, respectively. If both continuous and impulsive noise occurs in the same area, impacts are assessed separately for each.

D1.2.2 Land Use Compatibility

As noted above, the inherent variability between individuals makes it impossible to predict accurately how any individual will react to a given noise event. Nevertheless, when a community is considered as a whole, its overall reaction to noise can be represented with a high degree of confidence. As described above, the best noise exposure metric for this correlation is the L_{dn} or L_{dnmr} for military overflights. Impulsive noise can be assessed by relating CDNL to an "equivalent annoyance" L_{dn}, as outlined in Section 1.3.1.

In June 1980, an ad hoc Federal Interagency Committee on Urban Noise published guidelines (Federal Interagency Committee on Urban Noise 1980) relating L_{dn} to compatible land uses. This committee was composed of representatives from DoD, Transportation, and Housing and Urban Development; USEPA; and the Veterans Administration. Since the issuance of these guidelines, federal agencies have generally adopted these guidelines for their noise analyses.

Following the lead of the committee, DoD and FAA adopted the concept of land-use compatibility as the accepted measure of aircraft noise effect. The FAA included the committee's guidelines in the Federal Aviation Regulations (United States Department of Transportation 1984).

These guidelines are reprinted in Table D-2, along with the explanatory notes included in the regulation. Although these guidelines are not mandatory (note the footnote "*" in the table), they provide the best means for determining noise impact in airport communities. In general, residential land uses normally are not compatible with outdoor L_{dn} values above 65 dB, and the extent of land areas and populations exposed to L_{dn} of 65 dB and higher provides the best means for assessing the noise impacts of alternative aircraft actions. In some cases, where noise change exceeds 3 dB, the 1992 Federal Interagency Committee on Noise indicates the 60 dB L_{dn} may be a more appropriate incompatibility level for densely populated areas.

D2 Noise Effects

The discussion in Section 1.3 presents the global effect of noise on communities. The following sections describe particular noise effects.

D2.1 Hearing Loss

There are situations where noise in and around airbases may exceed levels at which long-term noise-induced hearing loss is possible.

The first of these is a result of exposure to occupational noise by individuals working in known high noise exposure locations such as jet engine maintenance facilities or aircraft maintenance hangers. In this case, exposure of workers inside the base boundary area should be considered occupational, which is excluded from the DoD Noise Program by DoD Instruction 4715.13, and should be evaluated using the appropriate DoD component regulations for occupational noise exposure. The DoD, U.S. Air Force, and the National Institute of Occupational Safety and Health (NIOSH) have all established occupational noise exposure damage risk criteria (or "standard") for hearing loss so as to not exceed 85 dB as an 8-hour time weighted average, with a 3 dB exchange rate in a work environment.

Table D-2. Land-Use Compatibility With Yearly Day-Night Average Sound Levels

Land Use	*Yearly Day-Night Average Sound Level (L_{dn}) in dB*					
	Below 65	**65–70**	**70–75**	**75–80**	**80–85**	**Over 85**
Residential						
Residential, other than mobile homes and transient lodgings	Y	N(1)	N(1)	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N(1)	N(1)	N(1)	N	N
Public Use						
Schools	Y	N(1)	N(1)	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoria, and concert halls	Y	25	30	N	N	N
Government services	Y	Y	25	30	N	N
Transportation	Y	Y	Y(2)	Y(3)	Y(4)	Y(4)
Parking	Y	Y	Y(2)	Y(3)	Y(4)	N
Commercial Use						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale and retail—building materials, hardware, and farm equipment	Y	Y	Y(2)	Y(3)	Y(4)	N
Retail trade—general	Y	Y	25	30	N	N
Utilities	Y	Y	Y(2)	Y(3)	Y(4)	N
Communication	Y	Y	25	30	N	N
Manufacturing and Production						
Manufacturing, general	Y	Y	Y(2)	Y(3)	Y(4)	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y(6)	Y(7)	Y(8)	Y(8)	Y(8)
Livestock farming and breeding	Y	Y(6)	Y(7)	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
Recreational						
Outdoor sports arenas and spectator sports	Y	Y(5)	Y(5)	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts, and camps	Y	Y	Y	N	N	N
Golf courses, riding stables, and water recreation	Y	Y	25	30	N	N

Numbers in parentheses refer to notes.

* The designations contained in this table do not constitute a federal determination that any use of land covered by the program is acceptable or unacceptable under federal, state, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under Part 150 are not intended to substitute federally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise-compatible land uses.

KEY TO TABLE D-2

Y (YES) = Land Use and related structures compatible without restrictions.

N (No) = Land Use and related structures are not compatible and should be prohibited.

NLR = Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.

25, 30, or 35 = Land Use and related structures generally compatible; measures to achieve NLR of 25, 30, or 35 dB must be incorporated into design and construction of structures.

NOTES FOR TABLE D-2

1. Where the community determines that residential or school uses must be allowed, measures to achieve outdoor-to-indoor Noise Level Reduction (NLR) of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide an NLR of 20 dB; thus the reduction requirements are often stated as 5, 10, or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year-round. However, the use of NLR criteria will not eliminate outdoor noise problems.

2 Measures to achieve NLR 25 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.

3 Measures to achieve NLR 30 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.

4 Measures to achieve NLR 35 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.

5 Land-use compatible provided special sound reinforcement systems are installed.

6 Residential buildings require an NLR of 25.

7 Residential buildings require an NLR of 30.

8 Residential buildings not permitted.

The exchange rate is an increment of decibels that requires the halving of exposure time, or a decrement of decibels that requires the doubling of exposure time. For example, a 3 dB exchange rate requires that noise exposure time be halved for each 3 dB increase in noise level. Therefore, an individual would achieve the limit for risk criteria at 88 dB, for a time period of 4 hours, and at 91 dB, for a time period of 2 hours.) (The standard assumes "quiet" (where an individual remains in an environment with noise levels less than 72 dB) for the balance of the 24-hour period. Also, Air Force and Occupational Safety and Health Administration (OSHA) occupational standards prohibit any unprotected worker exposure to continuous (i.e., of a duration greater than one second) noise exceeding a 115 dB sound level. OSHA established this additional standard to reduce the risk of workers developing noise-induced hearing loss.

The second situation where individuals may be exposed to high noise levels is when noise contours resulting from flight operations in and around the installation reach or exceed 80 dB L_{dn} both on- and off-base. To access the potential impacts of this situation, the DoD published a policy for assessing hearing loss risk (Undersecretary of Defense for Acquisition Technology and Logistics 2009). The policy defines the conditions under which assessments are required, references the methodology from a 1982 USEPA report, and describes how the assessments are to be calculated. The policy reads as follows:

"Current and future high performance aircraft create a noise environment in which the current impact analysis based primarily on annoyance may be insufficient to capture the full range of impacts on humans. As part of the noise analysis in all future environmental impact statements, DoD components will use the 80 Day-Night A-Weighted (L_{dn}) noise contour to identify populations at the most risk of potential hearing loss. DoD components will use as part of the analysis, as appropriate, a calculation of the Potential Hearing Loss (PHL) of the at risk population. The PHL (sometimes referred to as Population Hearing Loss) methodology is defined in USEPA Report No. 550/9-82-105, *Guidelines for Noise Impact Analysis*" (1982).

The USEPA *Guidelines for Noise Impact Analysis* (hereafter referred to as "USEPA Guidelines") specifically addresses the criteria and procedures for assessing the noise-induced hearing loss in terms of the Noise-Induced Permanent Threshold Shift (NIPTS), a quantity that defines the permanent change in hearing level, or threshold, caused by exposure to noise (USEPA 1982). Numerically, the NIPTS is the change in threshold averaged over the frequencies 0.5, 1, 2, and 4 kilohertz (kHz) that can be expected from daily exposure to noise over a normal working lifetime of 40 years, with the exposure beginning at an age of 20 years. A grand average of the NIPTS over time (40 years) and hearing sensitivity (10 to 90 percentiles of the exposed population) is termed the Average NIPTS. The Average NIPTS attributable to noise exposure for ranges of noise level in terms of L_{dn} is given in Table D-3.

Table D-3. Average NIPTS and 10th Percentile NIPTS as a Function of L_{dn}*

L_{dn}	*Average NIPTS (dB)***	*10th Percentile NIPTS (dB)***
80-81	3.0	7.0
81-82	3.5	8.0
82-83	4.0	9.0
83-84	4.5	10.0
84-85	5.5	11.0
85-86	6.0	12.0
86-87	7.0	13.5
87-88	7.5	15.0
88-89	8.5	16.5
89-90	9.5	18.0

dB = decibels; L_{dn} = Day-night Average Sound Level; NIPTS = Noise-induced Permanent Threshold Shift

*Relationships between L_{dn} and NIPTS were derived from CHABA 1977.

**NIPTS values rounded to the nearest 0.5 dB.

Thus, for a noise exposure within the 80-81 Ldn contour band, the expected lifetime average value of NIPTS (hearing loss) is 3.0 dB. The Average NIPTS is estimated as an average over all people included in the at risk population. The actual value of NIPTS for any given person will depend on their physical sensitivity to noise – some will experience more loss of hearing than others. The USEPA Guidelines provide information on this variation in sensitivity in the form of the NIPTS exceeded by 10 percent of the population, which is included in Table D-3 in the "10th Percentile NIPTS" column. As in the example above, for individuals within the 80-81 Ldn contour band, the most sensitive of the population, would be expected to show no more degradation to their hearing than experiencing a 7.0 dB Average NIPTS hearing loss. And while the DoD policy requires that hearing loss risk be estimated for the population exposed to 80 dB Ldn or greater, this does not preclude populations outside the 80 Ldn contour, i.e. at lower exposure levels, from being at some degree of risk of hearing loss.

The actual noise exposure for any person living in the at-risk area is determined by the time that person is outdoors and directly exposed to the noise. Many of the people living within the applicable L_{dn} contour will not be present during the daytime hours – they may be at work, at school, or involved in other activities outside the at-risk area. Many will be inside their homes and thereby exposed to lower noise levels, benefitting from the noise attenuation provided by the house structure. The actual activity profile is usually impossible to generalize. For the purposes of this analysis, it was assumed that residents are fully exposed to the L_{dn} level of noise appropriate for their residence location and the Average NIPTS taken from Table D-3. 3.

The quantity to be reported is the number of people living within each 1 dB contour band inside the 80 dB L_{dn} contour who are at risk for hearing loss given by the Average NIPTS for that band. The average nature of Average NIPTS means that it underestimates the magnitude of the potential hearing loss for the population most sensitive to noise. Therefore, in the interest of disclosure, the information to be reported includes both the Average NIPTS and the 10th percentile NIPTS Table D-3. 3) for each 1 dB contour band inside the 80 L_{dn} contour.

According to the USEPA documents titled Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, and Public Health and Welfare Criteria for Noise, changes in hearing levels of less than 5 dB are generally not considered noticeable or significant. There is no known evidence that an NIPTS of less than 5 dB is perceptible or has any practical significance for the individual. Furthermore, the variability in audiometric testing is generally assumed to be ± 5 dB. The preponderance of available information on hearing loss risk is from the workplace with continuous exposure throughout the day for many years. Clearly, this data is applicable to the adult working population. According to a report by Ludlow and Sixsmith, there were no significant differences in audiometric test results between military personnel, who as children had lived in or near stations where jet operations were based, and a similar group who had no such exposure as children (Ludlow and Sixsmith 1999). Hence, for the purposes of PHL analysis, it can be assumed that the limited data on hearing loss is applicable to the general population, including children, and provides a conservative estimate of hearing loss.

D2.2 Nonauditory Health Effects

Nonauditory health effects of long-term noise exposure, where noise may act as a risk factor, have not been found to occur at levels below those protective against noise-induced hearing loss, described above. Most studies attempting to clarify such health effects have found that noise exposure levels established for hearing protection will also protect against any potential nonauditory health effects, at least in workplace conditions. The best scientific summary of these findings is contained in the lead paper at the National Institutes of Health Conference on Noise and Hearing Loss, held on January 22–24, in Washington, D.C., which states, "The nonauditory effects of chronic noise exposure, when noise is suspected to act as one of the risk factors in the development of hypertension, cardiovascular disease, and other nervous disorders, have never been proven to occur as chronic manifestations at levels below these criteria (an average of 75 dBA for complete protection against hearing loss for an eight-hour day)" (von Gierke 1990; parenthetical wording added for clarification). At the International Congress (1988) on Noise as a Public Health Problem, most studies attempting to clarify such health effects did not find them at levels below the criteria protective of noise-induced hearing loss; and even above these criteria, results regarding such health effects were ambiguous.

Consequently, it can be concluded that establishing and enforcing exposure levels protecting against noise-induced hearing loss would not only solve the noise-induced hearing loss problem but also any potential nonauditory health effects in the work place.

Although these findings were directed specifically at noise effects in the work place, they are equally applicable to aircraft noise effects in the community environment. Research studies regarding the nonauditory health effects of aircraft noise are ambiguous, at best, and often contradictory. Yet, even those studies which purport to find such health effects use time-average noise levels of 75 dB and higher for their research.

For example, in an often-quoted paper, two University of California at Los Angeles researchers found a relation between aircraft noise levels under the approach path to Los Angeles International Airport and increased mortality rates among the exposed residents by using an average noise exposure level greater than 75 dB for the "noise-exposed" population (Meecham and Shaw 1979). Nevertheless, three other University of California at Los Angeles professors analyzed those same data and found no relation between noise exposure and mortality rates (Frerichs *et al*. 1980).

As a second example, two other University of California at Los Angeles researchers used this same population near Los Angeles International Airport to show a higher rate of birth defects during the period of 1970 to 1972 when compared with a control group residing away from the airport (Jones and Tauscher 1978). Based on this report, a separate group at the United States Centers for Disease Control performed a more thorough study of populations near Atlanta's Hartsfield International Airport for 1970 to 1972 and found no relation in their study of 17 identified categories of birth defects to aircraft noise levels above 65 dB (Edmonds 1979).

A recent review of health effects, prepared by a Committee of the Health Council of The Netherlands (Committee of the Health Council of the Netherlands 1996), analyzed currently available published information on this topic. The committee concluded that the threshold for possible long-term health effects was a 16-hour (6:00 a.m. to 10:00 p.m.) L_{eq} of 70 dB. Projecting this to 24 hours and applying the 10 dB nighttime penalty used with L_{dn}, this corresponds to L_{dn} of about 75 dB. The study also affirmed the risk threshold for hearing loss, as discussed earlier.

In summary, there is no scientific basis for a claim that potential health effects exist for aircraft time-average sound levels below 75 dB.

D2.3 Annoyance

The primary effect of aircraft noise on exposed communities is one of annoyance. Noise annoyance is defined by the USEPA as any negative subjective reaction on the part of an individual or group (USEPA 1974). As noted in the discussion of L_{dn} above, community annoyance is best measured by that metric.

Because the USEPA Levels Document (USEPA 1974) identified L_{dn} of 55 dB as ". . . requisite to protect public health and welfare with an adequate margin of safety," it is commonly assumed that 55 dB should be adopted as a criterion for community noise analysis. From a noise exposure perspective, that would be an ideal selection. However, financial and technical resources are generally not available to achieve that goal. Most agencies have identified L_{dn} of 65 dB as a criterion which protects those most impacted by noise, and which can often be achieved on a practical basis (Federal Interagency Committee on Noise 1992). This corresponds to about 13 percent of the exposed population being highly annoyed.

Although L_{dn} of 65 dB is widely used as a benchmark for significant noise impact, and is often an acceptable compromise, it is not a statutory limit, and it is appropriate to consider other thresholds in particular cases.

In this Draft EA, no specific threshold is used. The noise in the affected environment is evaluated on the basis of the information presented in this appendix and in the body of the Draft EA.

Community annoyance from sonic booms is based on CDNL, as discussed in Section 1.3. These effects are implicitly included in the "equivalent annoyance" CDNL values in Table D-1, since those were developed from actual community noise impact.

D2.4 Speech Interference

Speech interference associated with aircraft noise is a primary cause of annoyance to individuals on the ground. The disruption of routine activities in the home, such as radio or television listening, telephone use, or family conversation, gives rise to frustration and irritation. The quality of speech communication is also important in classrooms, offices, and industrial settings and can cause fatigue and vocal strain in those who attempt to communicate over the noise. Research has shown that the use of the SEL metric will measure speech interference successfully, and that a SEL exceeding 65 dB will begin to interfere with speech communication.

D2.5 Sleep Interference

Sleep interference is another source of annoyance associated with aircraft noise. This is especially true because of the intermittent nature and content of aircraft noise, which is more disturbing than continuous noise of equal energy and neutral meaning.

Sleep interference may be measured in either of two ways. "Arousal" represents actual awakening from sleep, while a change in "sleep stage" represents a shift from one of four sleep stages to another stage of lighter sleep without actual awakening. In general, arousal requires a somewhat higher noise level than does a change in sleep stage.

An analysis sponsored by the Air Force summarized 21 published studies concerning the effects of noise on sleep (Pearsons *et al*. 1989). The analysis concluded that a lack of reliable in-home studies, combined with large differences among the results from the various laboratory studies, did not permit development of an acceptably accurate assessment procedure. The noise events used in the laboratory studies and in contrived in-home studies were presented at much higher rates of occurrence than would normally be experienced. None of the laboratory studies were of sufficiently long duration to determine any effects of habituation, such as that which would occur under normal community conditions. A recent extensive study of sleep interference in people's own homes (Ollerhead 1992) showed very little disturbance from aircraft noise.

There is some controversy associated with the recent studies, so a conservative approach should be taken in judging sleep interference. Based on older data, the USEPA identified an indoor L_{dn} of 45 dB as necessary to protect against sleep interference (USEPA 1974). Assuming a very conservative structural noise insulation of 20 dB for typical dwelling units, this corresponds to an outdoor L_{dn} of 65 dB as minimizing sleep interference.

A 1984 publication reviewed the probability of arousal or behavioral awakening in terms of SEL (Kryter 1984). Figure D-4, extracted from Figure 10.37 of Kryter (1984), indicates that an indoor SEL of 65 dB or lower should awaken less than 5 percent of those exposed. These results do not include any habituation over time by sleeping subjects. Nevertheless, this provides a reasonable guideline for assessing sleep interference and corresponds to similar guidance for speech interference, as noted above.

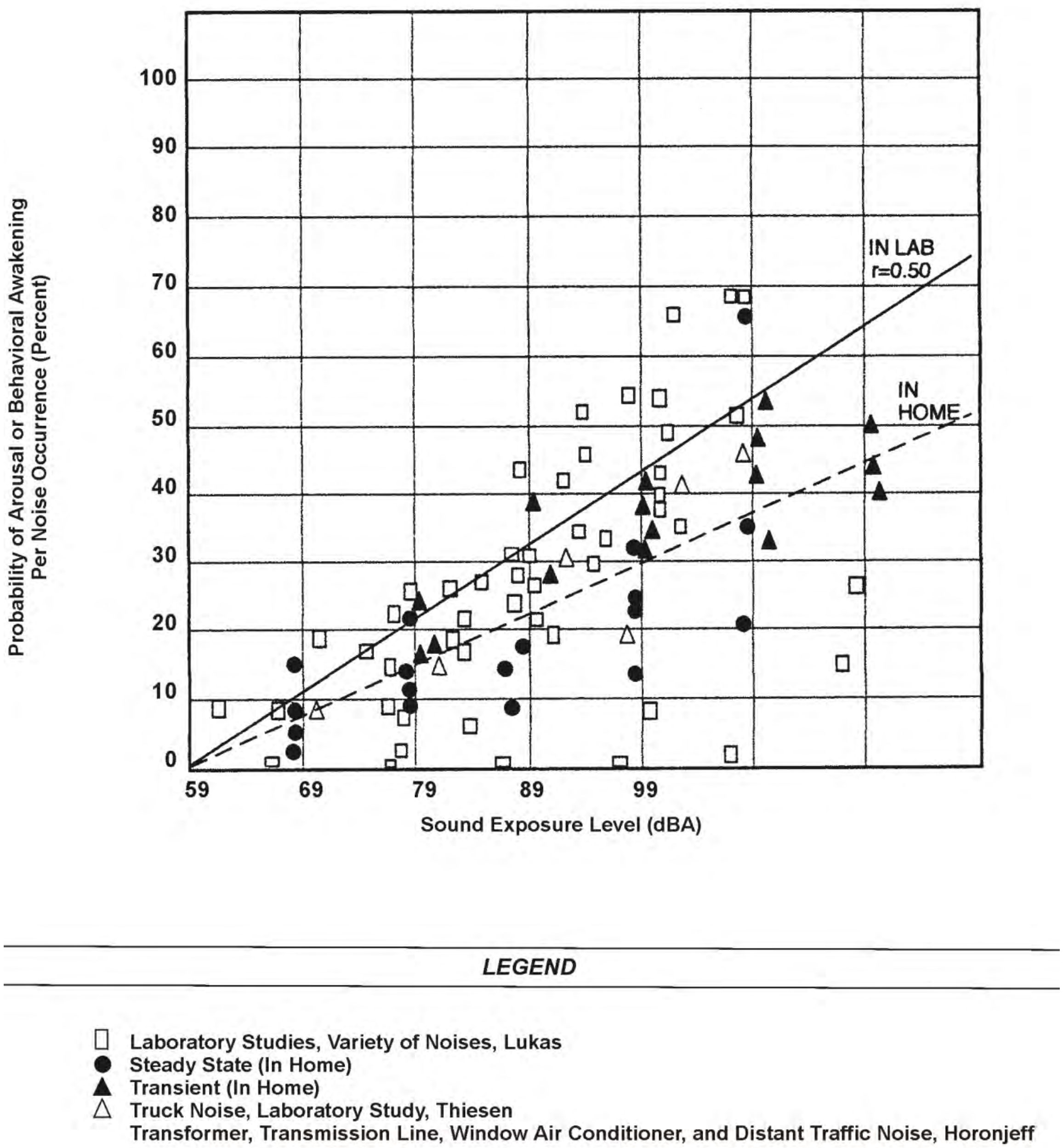


Figure D-4. Probability of Arousal or Behavioral Awakening in Terms of Sound Exposure Level

D2.6 Noise Effects on Domestic Animals and Wildlife

Animal species differ greatly in their responses to noise. Each species has adapted, physically and behaviorally, to fill its ecological role in nature, and its hearing ability usually reflects that role. Animals rely on their hearing to avoid predators, obtain food, and communicate with and attract other members of their species. Aircraft noise may mask or interfere with these functions. Secondary effects may include nonauditory effects similar to those exhibited by humans: stress, hypertension, and other nervous disorders. Tertiary effects may include interference with mating and resultant population declines.

D2.7 Noise Effects on Structures

D2.7.1 Subsonic Aircraft Noise

Normally, the most sensitive components of a structure to airborne noise are the windows and, infrequently, the plastered walls and ceilings. An evaluation of the peak sound pressures impinging on the structure is normally sufficient to determine the possibility of damage. In general, at sound levels above 130 dB, there is the possibility of the excitation of structural component resonance. While certain frequencies (such as 30 Hz for window breakage) may be of more concern than other frequencies, conservatively, only sounds lasting more than one second above a sound level of 130 dB are potentially damaging to structural components (National Research Council/National Academy of Sciences 1977).

A study directed specifically at low-altitude, high-speed aircraft showed that there is little probability of structural damage from such operations (Sutherland 1989). One finding in that study is that sound levels at damaging frequencies (e.g., 30 Hz for window breakage or 15 to 25 Hz for whole-house response) are rarely above 130 dB.

Noise-induced structural vibration may also cause annoyance to dwelling occupants because of induced secondary vibrations, or "rattle," of objects within the dwelling, such as hanging pictures, dishes, plaques, and bric-a-brac. Window panes may also vibrate noticeably when exposed to high levels of airborne noise, causing homeowners to fear breakage. In general, such noise-induced vibrations occur at sound levels above those considered normally incompatible with residential land use. Thus assessments of noise exposure levels for compatible land use should also be protective of noise-induced secondary vibrations.

D2.7.2 Sonic Booms

Sonic booms are commonly associated with structural damage. Most damage claims are for brittle objects, such as glass and plaster. Table D-4 summarizes the threshold of damage that might be expected at various overpressures. There is a large degree of variability in damage experience, and much damage depends on the pre-existing condition of a structure. Breakage data for glass, for example, spans a range of two to three orders of magnitude at a given overpressure. At 1 psf, the probability of a window breaking ranges from one in a billion (Sutherland 1990) to one in a million (Hershey and Higgins 1976). These damage rates are associated with a combination of boom load and glass condition. At 10 psf, the probability of breakage is between one in a hundred and one in a thousand. Laboratory tests of glass (White 1972) have shown that properly installed window glass will not break at overpressures below 10 psf, even when subjected to repeated booms, but in the real world glass is not in pristine condition.

Table D-4. Possible Damage to Structures From Sonic Booms

Sonic Boom Overpressure Nominal (psf)	Item Affected	Type of Damage
0.5 - 2	Plaster	Fine cracks; extension of existing cracks; more in ceilings; over door frames; between some plaster boards.
	Glass	Rarely shattered; either partial or extension of existing cracks.
	Roof	Slippage of existing loose tiles/slates; sometimes new cracking of old slates at nail hole.
	Damage to outside walls	Existing cracks in stucco extended.
	Bric-a-brac	Those carefully balanced or on edges can fall; fine glass, such as large goblets, can fall and break.
	Other	Dust falls in chimneys.
2 - 4	Glass, plaster, roofs, ceilings	For elements nominally in good condition, failures show that would have been difficult to forecast in terms of their existing localized condition.
4 - 10	Glass	Regular failures within a population of well-installed glass; industrial as well as domestic greenhouses.
	Plaster	Partial ceiling collapse of good plaster; complete collapse of very new, incompletely cured, or very old plaster.
	Roofs	High probability rate of failure in slurry wash in nominally good state; some chance of failures in tiles on modern roofs; light roofs (bungalow) or large area can move bodily.
	Walls (out)	Old, free standing, in fairly good condition can collapse.
	Walls (in)	Internal (“party”) walls known to move at 10 psf.
Greater than 10	Glass	Some good window glass will fail when exposed to regular sonic booms from the same direction. Glass with existing faults could shatter and fly. Large window frames move.
	Plaster	Most plaster affected.
	Ceilings	Plaster boards displaced by nail popping.
	Roofs	Most slate/slurry roofs affected, some badly; large roofs having good tile can be affected; some roofs bodily displaced causing gale-end and wall-plate cracks; domestic chimneys dislodged if not in good condition.
	Walls	Internal party walls can move even if carrying fittings such as hand basins or taps; secondary damage due to water leakage.
	Bric-a-brac	Some nominally secure items can fall; e.g., large pictures, especially if fixed to party walls.

Source: Haber and Nakaki 1989

Some degree of damage to glass and plaster should thus be expected whenever there are sonic booms, but usually at the low rates noted above. In general, structural damage from sonic booms should be expected only for overpressures above 10 psf.

D2.8 Noise Effects on Terrain

D2.8.1 Subsonic Aircraft Noise

Members of the public often believe that noise from low-flying aircraft can cause avalanches or landslides by disturbing fragile soil or snow structures in mountainous areas. There are no known instances of such effects, and it is considered improbable that such effects will result from routine, subsonic aircraft operations**.**

D2.8.2 Sonic Booms

In contrast to subsonic noise, sonic booms are considered to be a potential trigger for snow avalanches. Avalanches are highly dependent on the physical status of the snow, and do occur spontaneously. They can be triggered by minor disturbances, and there are documented accounts of sonic booms triggering avalanches. Switzerland routinely restricts supersonic flight during avalanche season.

Landslides are not an issue for sonic booms. There was one anecdotal report of a minor landslide from a sonic boom generated by the Space Shuttle during landing, but there is no credible mechanism or consistent pattern of reports.

D2.9 Noise Effects on Historical and Archaeological Sites

Because of the potential for increased fragility of structural components of historical buildings and other historical sites, aircraft noise may affect such sites more severely than newer, modern structures. Again, there are few scientific studies of such effects to provide guidance for their assessment.

One study involved the measurements of sound levels and structural vibration levels in a superbly restored plantation house, originally built in 1795, and now situated approximately 1,500 feet from the centerline at the departure end of Runway 19L at Washington Dulles International Airport. These measurements were made in connection with the proposed scheduled operation of the supersonic Concorde airplane at Dulles (Wesler 1977). There was special concern for the building’s windows, since roughly half of the 324 panes were original. No instances of structural damage were found. Interestingly, despite the high levels of noise during Concorde takeoffs, the induced structural vibration levels were actually less than those induced by touring groups and vacuum cleaning within the building itself.

As noted above for the noise effects of noise-induced vibrations on normal structures, assessments of noise exposure levels for normally compatible land uses should also be protective of historic and archaeological sites.

D3 Noise Modeling

D3.1 Subsonic Aircraft Noise

An aircraft in subsonic flight generally emits noise from two sources: the engines and flow noise around the airframe. Noise generation mechanisms are complex and, in practical models, the noise sources must be based on measured data. The Air Force has developed a series of computer models and aircraft noise databases for this purpose. The models include NOISEMAP (Moulton 1992) for noise around airbases, ROUTEMAP (Lucas and Plotkin 1988) for noise associated with low-level training routes, and MR_NMAP (Lucas and Calamia 1996) for use in MOAs and ranges. These models use the NOISEFILE database developed by the Air Force. NOISEFILE data includes SEL and L_{Amax} as a function of speed and power setting for aircraft in straight flight.

Noise from an individual aircraft is a time-varying continuous sound. It is first audible as the aircraft approaches, increases to a maximum when the aircraft is near its closest point, then diminishes as it departs. The noise depends on the speed and power setting of the aircraft and its trajectory. The models noted above divide the trajectory into segments whose noise can be computed from the data in NOISEFILE. The contributions from these segments are summed.

MR_NMAP was used to compute noise levels in the airspace. The primary noise metric computed by MR_NMAP was L_{dnmr} averaged over each airspace. Supporting routines from NOISEMAP were used to calculate SEL and L_{Amax} for various flight altitudes and lateral offsets from a ground receiver position.

D3.2 Sonic Booms

When an aircraft moves through the air, it pushes the air out of its way. At subsonic speeds, the displaced air forms a pressure wave that disperses rapidly. At supersonic speeds, the aircraft is moving too quickly for the wave to disperse, so it remains as a coherent wave. This wave is a sonic boom. When heard at the ground, a sonic boom consists of two shock waves (one associated with the forward part of the aircraft, the other with the rear part) of approximately equal strength and (for fighter aircraft) separated by 100 to 200 milliseconds. When plotted, this pair of shock waves and the expanding flow between them have the appearance of a capital letter “N,” so a sonic boom pressure wave is usually called an “N-wave.” An N-wave has a characteristic "bang-bang" sound that can be startling. Figure D-5 shows the generation and evolution of a sonic boom N-wave under the aircraft. Figure D-6 shows the sonic boom pattern for an aircraft in steady supersonic flight. The boom forms a cone that is said to sweep out a “carpet” under the flight track.

The complete ground pattern of a sonic boom depends on the size, shape, speed, and trajectory of the aircraft. Even for a nominally steady mission, the aircraft must accelerate to supersonic speed at the start, decelerate back to subsonic speed at the end, and usually change altitude. Figure D-7 illustrates the complexity of a nominal full mission.

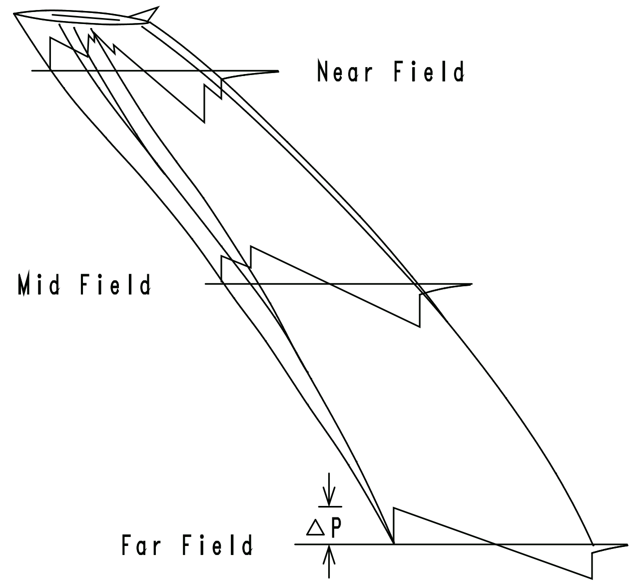


Figure D-5. Sonic Boom Generation, and Evolution to N-wave

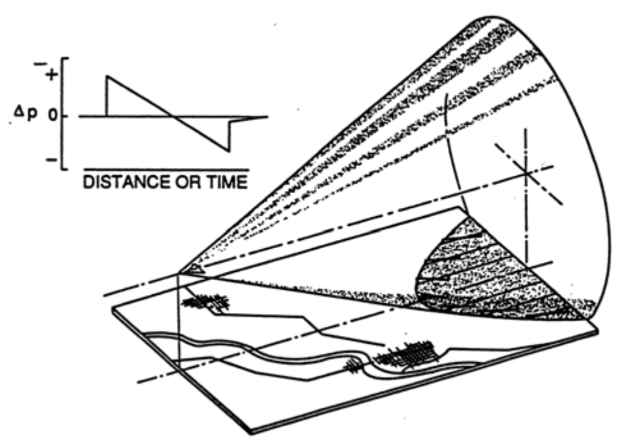


Figure D-6. Sonic Boom Carpet in Steady Flight

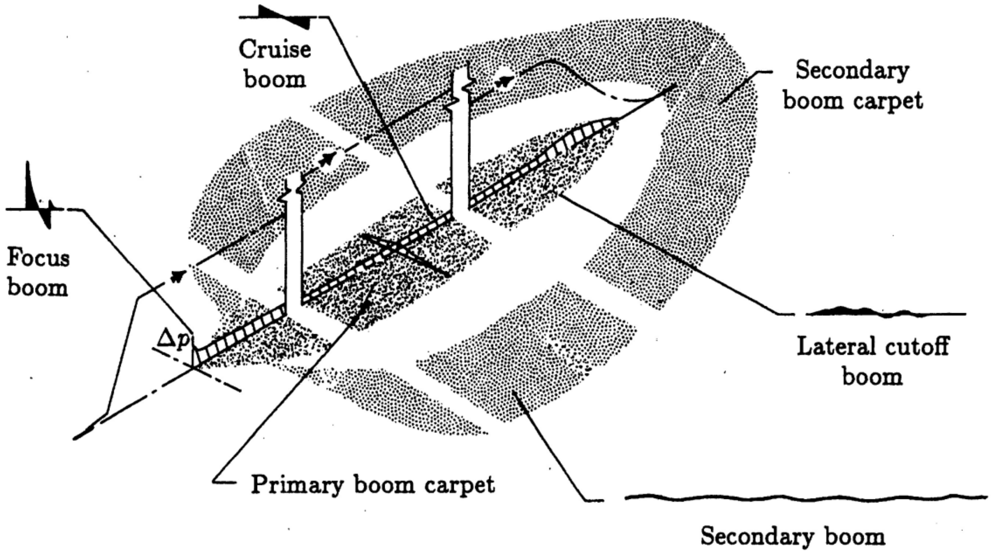


Figure D-7. Complex Sonic Boom Pattern for Full Mission

The Air Force's PCBoom4 computer program (Plotkin and Grandi 2002) can be used to compute the complete sonic boom footprint for a given single event, accounting for details of a particular maneuver.

Supersonic operations for the proposed action and alternatives are, however, associated with air combat training, which cannot be described in the deterministic manner that PCBoom4 requires. Supersonic events occur as aircraft approach an engagement, break at the end, and maneuver for advantage during the engagement. Long time cumulative sonic boom exposure, CDNL, is meaningful for this kind of environment.

Long-term sonic boom measurement projects have been conducted in four supersonic air combat training airspaces: White Sands, New Mexico (Plotkin *et al.* 1989); the eastern portion of the Goldwater Range, Arizona (Plotkin *et al.* 1992); the Elgin MOA at Nellis AFB, Nevada (Frampton *et al.* 1993); and the western portion of the Goldwater Range (Page *et al.* 1994). These studies included analysis of schedule and air combat maneuvering instrumentation data and supported development of the 1992 BOOMAP model (Plotkin *et al.* 1992). The current version of BOOMAP (Frampton *et al.* 1993; Plotkin 1996) incorporates results from all four studies.

Because BOOMAP is directly based on long-term measurements, it implicitly accounts for such variables as maneuvers, statistical variations in operations, atmosphere effects, and other factors.

Figure D-8 shows a sample of supersonic flight tracks measured in the air combat training airspace at White Sands (Plotkin *et al.* 1989). The tracks fall into an elliptical pattern aligned with preferred engagement directions in the airspace. Figure D-9 shows the CDNL contours that were fit to six months of measured booms in that airspace. The subsequent measurement programs refined the fit, and demonstrated that the elliptical maneuver area is related to the size and shape of the airspace (Frampton *et al*. 1993). BOOMAP quantifies the size and shape of

CDNL contours, and also numbers of booms per day, in air combat training airspaces. That model was used for prediction of cumulative sonic boom exposure in the study area.

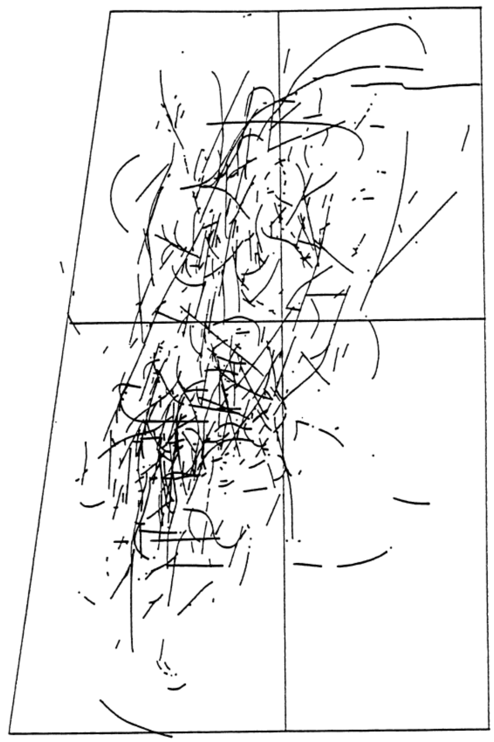


Figure D-8. Supersonic Flight Tracks in Supersonic Air Combat Training Airspace

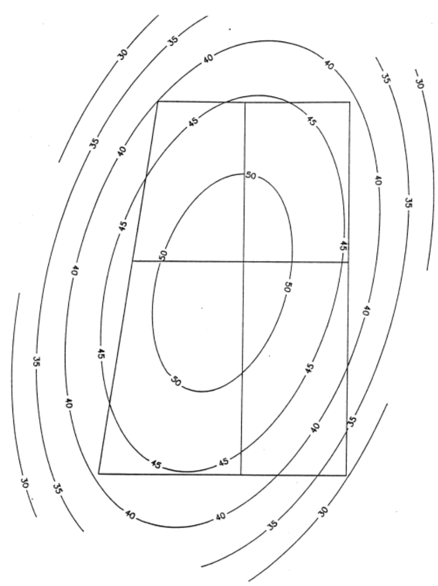


Figure D-9. Elliptical CDNL Contours in Supersonic Air Combat Training Airspace

D4 Summary of Operational Parameters Used in Noise Modeling at JBER-Elmendorf

Operational parameters used in modeling of noise in the vicinity of JBER-Elmendorf are summarized below. Parameters presented are representative of current operations at JBER-Elemendorf as reported during operator interviews held in August 2009. Operations of F-22 and C-17 aircraft have the greatest potential to affect off-installation noise sensitive areas. Operations data for these two aircraft were updated and revised in December 2010 and March 2011. Runway usage and the number of events per average busy day are critical factors affecting time-averaged noise levels. Table D-5 presents the percent of total arrivals, departures, and closed patterns that use each runway as well as the number of each type of event that occurs per average busy day. Increased usage of the crosswind runway (16/34) has the potential to increase noise levels in residential areas south of JBER-Elmendorf to greater than 65 L_{dn}

Table D-5. Summary of Operational Parameters Used at JBER-Elmendorf

Aircraft	*Operation Type*	*# per Average Busy Day*	*% Runway Usage*			
			6	16	24	34
C-12	Arrival	2.65	76	1	15	8
	Closed	1.33	97	0	0	3
	Departure	2.65	26	9	65	0
	Interfacility	0	n/a	n/a	n/a	n/a
C-130	Arrival	8.98	71	12	17	0
	Closed	7.60	69	31	0	0
	Departure	8.98	80	0	20	0
	Interfacility	5.90	64	0	0	36
C-17	Arrival	3.01	95	4	1	0
	Closed	9.69	83	7	8	1
	Departure	3.01	85	0	15	0
	Interfacility	8.78	76	0	24	0
E-3	Arrival	1.00	73	0	27	0
	Closed	3.11	76	0	24	0
	Departure	1.00	60	0	40	0
	Interfacility	0	n/a	n/a	n/a	n/a
F-22	Arrival	19.05	100	0	0	0
	Closed	2.73	100	0	0	0
	Departure	19.05	75	25	0	0
	Interfacility	0.00	n/a	n/a	n/a	n/a
Aeroclub	Arrival	5.38	90	2	5	3
	Closed	0.97	90	2	5	3
	Departure	5.38	90	2	5	3
	Interfacility	0	n/a	n/a	n/a	n/a
UC-35	Arrival	2.04	85	2	10	3
	Closed	0.07	90	3	4	3
	Departure	2.04	95	1	2	2
	Interfacility	0	n/a	n/a	n/a	n/a

D5 References

American National Standards Institute. 1980. Sound Level Descriptors for Determination of Compatible Land Use. American National Standards Institute Standard ANSI S3.23-1980.

_______. 1988. Quantities and Procedures for Description and Measurement of Environmental Sound, Part 1. American National Standards Institute Standard ANSI S12.9-1988.

Committee on Hearing, Bioacoustics and Biomechanics. 1981. Assessment of Community Noise Response to High-Energy Impulsive Sounds. Report of Working Group 84, Committee on Hearing, Bioacoustics and Biomechanics, Assembly of Behavioral and Social Sciences. National Research Council, National Academy of Sciences. Washington, DC.

Committee of the Health Council of the Netherlands. 1996. Effects of Noise on Health. Noise/News International 4. September.

Edmonds, L.D., P.M. Layde, and J.D. Erickson. 1979. *Airport Noise and Teratogenesis*. Archives of Environmental Health, 243-247. July/August.

Federal Interagency Committee on Noise. 1992. Federal Agency Review of Selected Airport Noise Analysis Issues. Federal Interagency Committee on Noise. August.

Federal Interagency Committee on Urban Noise. 1980. Guidelines for Considering Noise in Land-Use Planning and Control. Federal Interagency Committee on Urban Noise. June.

Fidell, S., D.S. Barger, and T.J. Schultz. 1991. Updating a Dosage-Effect Relationship for the Prevalence of Annoyance Due to General Transportation Noise. *J. Acoust. Soc. Am.*, 89, 221-233. January.

Finegold, L.S., C.S. Harris, and H.E. von Gierke. 1994. Community Annoyance and Sleep Disturbance: Updated Criteria for Assessing the Impacts of General Transportation Noise on People. In *Noise Control Engineering Journal*, Volume 42, Number 1. pp. 25-30. January-February.

Frampton, K.D., M.J. Lucas, and B. Cook. 1993. Modeling the Sonic Boom Noise Environment in Military Operating Areas. AIAA Paper 93-4432.

Frerichs, R.R., B.L. Beeman, and A.H. Coulson. 1980. Los Angeles Airport Noise and Mortality: Faulty Analysis and Public Policy. *Am. J. Public Health*, 357-362. April.

Haber, J. and D. Nakaki. 1989. Sonic Boom Damage to Conventional Structures. HSD-TR-89-001. April.

Harris, C.M. (editor). 1979. *Handbook of Noise Control*. McGraw-Hill.

Hershey, R.L. and T.H. Higgins. 1976, "Statistical Model of Sonic Boom Structural Damage," FAA-RD-76-87, July 1976

Jones, F.N. and J. Tauscher. 1978. Residence Under an Airport Landing Pattern as a Factor in Teratism. *Archives of Environmental Health*, 10-12. January/February.

Kryter, K.D. 1984. Physiological, Psychological, and Social Effects of Noise. *NASA Reference Publication* 1115, 446. July.

Lucas, M.J. and P.T. Calamia. 1996. Military Operations Area and Range Noise Model: NRNMAP User's Manual. Final. Wright-Patterson AFB, Ohio: AAMRL. A1/OE-MN-1996-0001.

Lucas, M.J. and K. Plotkin. 1988. ROUTEMAP Model for Predicting Noise Exposure From Aircraft Operations on Military Training Routes. Final, Wright-Patterson AFB, Ohio. AAMRL. AAMRL-TR-88-060.

Ludlow and Sixsmith, 1999. Long Term Effects of Military Jet Aircraft Noise Exposure During Childhood on Hearing Threshold Levels. Noise and Health (5) 33-39.

Meecham, W.C. and N. Shaw. 1979. Effects of Jet Noise on Mortality Rates. *British J. Audiology*, 77-80. August.

Moulton, C.L. 1992. Air Force Procedure for Predicting Noise Around Airbases: Noise Exposure Model (NOISEMAP). Technical Report AL-TR-1992-59.

National Research Council/National Academy of Sciences. 1977. Guidelines for Preparing Environmental Impact Statements on Noise. Committee on Hearing, Bioacoustics, and Biomechanics.

Ollerhead, J.B., C.J. Jones, R.E. Cadoux, A. Woodley, B.J. Atkinson, J.A. Horne, F. Pankhurst, L. Reyner, K.I. Hume, F. Van, A. Watson, I.D. Diamond, P. Egger, D. Holmes, and J. McKean. 1992. Report of a Field Study of Aircraft Noise and Sleep Disturbance. The Department of Transport, Department of Safety Environment and Engineering. Civil Aviation Authority, London. December.

Page, J.A., B.D. Schantz, R. Brown, K.J. Plotkin, and C.L. Moulton. 1994. "Measurements of Sonic Booms Due to ACM Training in R2301 W of the Barry Goldwater Air Force Range," Wyle Research Report WR 94-11.

Pearsons, K.S., D.S. Barber, and B.G. Tabachick. 1989. Analyses of the Predictability of Noise-Induced Sleep Disturbance. USAF Report HSD-TR-89-029. October.

Plotkin, K.J., V.R. Desai, C.L. Moulton, M.J. Lucas, and R. Brown. 1989. "Measurements of Sonic Booms due to ACM Training at White Sands Missile Range," Wyle Research Report WR 89-18.

Plotkin, K.J., C.L. Moulton, V.R. Desai, and M.J. Lucas. 1992. “Sonic Boom Environment under a Supersonic Military Operations Area,” Journal of Aircraft 29(6): 1069-1072.

Plotkin, K.J., 1996. PCBoom3 Sonic Boom Prediction Model: Version 1.0c. Wyle Research Report WR 95-22C. May.

Plotkin, K.J. and F. Grandi, 2002. "Computer Models for Sonic Boom Analysis: PCBoom4, CABoom, BooMap, CORBoom," Wyle Research Report WR 02-11, June 2002.

Plotkin, K.J., L.C. Sutherland, and J.A. Molino. 1987. Environmental Noise Assessment for Military Aircraft Training Routes, Volume II: Recommended Noise Metric. Wyle Research Report WR 86-21. January.

Schultz, T.J. 1978. Synthesis of Social Surveys on Noise Annoyance. *J. Acoust. Soc. Am.*, 64, 377-405. August.

Stusnick, E., K.A. Bradley, J.A. Molino, and G. DeMiranda. 1992. The Effect of Onset Rate on Aircraft Noise Annoyance. Volume 2: Rented Own-Home Experiment. Wyle Laboratories Research Report WR 92-3. March.

Stusnick, E., K.A. Bradley, M.A. Bossi, and D.G. Rickert. 1993. The Effect of Onset Rate on Aircraft Noise Annoyance. Volume 3: Hybrid Own-Home Experiment. Wyle Laboratories Research Report WR 93-22. December.

Sutherland, L. 1989. Assessment of Potential Structural Damage from Low Altitude Subsonic Aircraft. Wyle Laboratories Research Report WR 89-16. El Segundo, CA.

Sutherland, L.C. 1990. "Effects of Sonic Boom on Structures," Lecture 3 of *Sonic Boom: Prediction and Effects*, AIAA Short Course, October 1990.

U.S. Department of Transportation. 1984. Airport Noise Compatibility Planning; Development of Submission of Airport Operator’s Noise Exposure Map and Noise Compatibility Program; Final Rule and Request for Comments. 14 CFR Parts 11 and 150, Federal Register 49(244): 18 December.

Undersecretary of Defense for Acquisition, Technology and Logistics. 2009. Methodology for Assessing Hearing Loss Risk and Impacts in DoD Environmental Impact Analysis. June 16.

United States Environmental Protection Agency (USEPA). 1974. Information on Levels of Environmental Noise Requisite to Protect the Public Health and Welfare With an Adequate Margin of Safety. U.S. Environmental Protection Agency Report 550/9-74-004. March.

U.S. Environmental Protection Agency (USEPA), 1982. *Guidelines for Noise Impact Analysis*. Report No. 550/9-82-105. April 1982.

von Gierke, H.R. 1990. The Noise-Induced Hearing Loss Problem. NIH Consensus Development Conference on Noise and Hearing Loss. Washington, D.C. 22-24 January.

Wesler, J.E. 1977. Concorde Operations At Dulles International Airport. NOISEXPO '77, Chicago, IL. March.

White, R. 1972. Effects of Repetitive Sonic Booms on Glass Breakage. FAA Report FAA-RD-72-43. April.

This page intentionally left blank.

Appendix E

Sec 7 (ESA) Compliance Wildlife Analysis for F-22 Plus UP Environmental Assessment,
Joint Base Elmendorf-Richardson (JBER), Alaska

This page intentionally left blank.

SECTION 7 (ENDANGERED SPECIES ACT) COMPLIANCE WILDLIFE ANALYSIS FOR F-22 PLUS-UP ENVIRONMENTAL ASSESSMENT

JOINT BASE ELMENDORF-RICHARDSON (JBER), ALASKA

February 2011

SECTION 7 (ENDANGERED SPECIES ACT) COMPLIANCE WILDLIFE ANALYSIS FOR F-22 PLUS-UP ENVIRONMENTAL ASSESSMENT, JOINT BASE ELMENDORF-RICHARDSON (JBER), ALASKA

1.1 Introduction

The United States Air Force (Air Force) is preparing an F-22 Plus-Up Environmental Assessment (EA) to evaluate the potential environmental consequences of the proposal to add six primary and one back-up F-22 aircraft to the Joint Base Elmendorf-Richardson (JBER) F-22 inventory, an increase in primary aircraft of approximately 17 percent.

1.2 Purpose and Need for F-22 Plus-Up at JBER

In 2006 the Air Force selected Elmendorf Air Force Base (AFB), Alaska, as the location for the Second F-22 Operational Wing [F-22 Beddown Environmental Assessment (EA), Elmendorf, Alaska, and Finding of No Significant Impact (FONSI), date 2006].

1.2.1 Purpose for F-22 Plus-Up at JBER

On July 29, 2010, the Department of the Air Force announced actions to consolidate the F-22 fleet. The Secretary of the Air Force and the Chief of Staff of the Air Force determined that the most effective basing for the F-22 requires redistributing aircraft from one Holloman AFB, New Mexico F-22 squadron to existing F-22 units at JBER; Langley AFB, Virginia; and Nellis AFB, Nevada. The second Holloman AFB F-22 squadron would be relocated to Tyndall AFB, Florida, an existing F-22 base. This consolidation would maximize combat aircraft and squadrons available for contingencies, and enhance F-22 operational flexibility (Air Force 2010). The purpose of the proposed plus-up of F-22 aircraft at JBER is to provide additional Air Force capabilities at a strategic location to meet mission responsibilities for worldwide deployment.

1.2.2 Need for F-22 Plus-Up at JBER

Two squadrons of F-15C aircraft and one squadron of F-15E aircraft were relocated from JBER between 2005 and 2010. Since World War II, JBER has provided an advanced location on U.S. soil for projection of U.S. global interests. Additional F-22 aircraft are needed at JBER to provide U.S. Air Force capability to respond efficiently to national objectives, be available for contingencies, and enhance F-22 operational flexibility.

1.3 Project Description

The Proposed Action is to augment the existing F-22 Operational Wing at JBER with six primary aircraft and one backup aircraft. This augmentation, when added to the existing JBER 36 primary and three back-up F-22 aircraft, would result in two F-22 squadrons with 21 primary and two back-up aircraft each. Addition of the six primary and one back-up F-22 aircraft would not require additional construction or physical modification of habitat, and no changes would occur to JBER Water Resources, Hazardous Materials/Waste, Cultural Resources, and Geology and Soils. No changes to current F-22 flight paths or approach and departure patterns would occur. With the addition of the six operational aircraft to the existing inventory, an increase in F-22 sorties of approximately 21 percent is expected to result. The "no action" alternative considered in the EA would not add seven aircraft to the inventory.

1.4 Threatened, Endangered, and Candidate Species to be Evaluated

Threatened, Endangered, and Candidate Species Identified by USFWS (2010a) or NOAA-NMFS (2010) Suspected or Recorded in Upper Cook Inlet Project Area

Common Name	*Scientific Name*	*ESA Status*	*Location Description*
Beluga Whale (Cook Inlet Distinct Population Segment [DPS])	*Delphinapterus leucas*	Endangered	Occupies Cook Inlet waters including Knik Arm and waters of North Gulf of Alaska (NMFS 2008a)
Steller Sea Lion* (Western AK DPS)	*Eumetopias jubatus*	Endangered	Includes sea lions born on rookeries from Prince William Sound westward (NMFS 2008b).
Steller's Eider*	*Polysticta stelleri*	Threatened	Occurs in northern and western Alaska (USDI 2007).
Yellow-billed Loon*	*Gavia adamsii*	Candidate	Nest near freshwater lakes in the arctic tundra and winter along the Alaskan coast to the Puget Sound (USDI 2009a).
Kittlitz's Murrelet*	*Brachyramphus brevirostris*	Candidate	Nest near glaciers in rocky slopes near Gulf of Alaska waters, winters off shore in Gulf of Alaska (USDI 2010b)
Northern Sea Otter Southwest Alaska DPS*	*Enhydra lutris kenyoni*	Threatened	Alaska Peninsula to the western Aleutian Islands. The nearest Management Unit [Kodiak, Kamishak Alaska Peninsula (KKAP)] includes the western shore of the lower Cook Inlet south of the project area USFWS 2010c).
Chinook salmon*: Lower Columbia River (spring) Puget Sound Snake River (spring/summer) Snake River (fall) Upper Columbia River (spring)	*Onchorhynchus tshawytshca*	Threatened Threatened Threatened Threatened Endangered Threatened	These stock range throughout the North Pacific. However, the specific occurrence of listed salmonids within close proximity to Elmendorf AFB is highly unlikely (NMFS 2010).

Threatened, Endangered, and Candidate Species Identified by USFWS (2010a) or NOAA-NMFS (2010) Suspected or Recorded in Upper Cook Inlet Project Area

Common Name	*Scientific Name*	*ESA Status*	*Location Description*
Upper Willamette River			
Steelhead*: Lower Columbia River Middle Columbia River Snake River Basin Upper Columbia River Upper Willamette River	*Onchorhynchus mykiss*	Threatened Threatened Threatened Endangered Threatened	These stock range throughout the North Pacific. However, the specific occurrence of listed salmonids within close proximity to Elmendorf AFB is highly unlikely (NMFS 2010).

Note:

* May potentially move on or within close proximity to base, but occur so infrequently that projects are expected to have no effect on them (USFWS 2010a, NMFS 2010).

1.5 Threatened, Endangered, and Candidate Species Recorded in Anchorage/Upper Cook Inlet Area

1.5.1 Beluga Whale, Cook Inlet Distinct Population Segment (DPS)

Biology: See "National Marine Fisheries Service. 2008a. Conservation Plan for the Cook Inlet beluga whale (*Delphinapterus leucas*). National Marine Fisheries Service, Juneau, Alaska. 122 pages."

Status: Endangered (Dec 2008) (73 FR 62919)

Critical Habitat: Proposed (74 FR 63080) December 2, 2009 but no final rule as of December 20, 2010. Area 1 of the proposed CH includes Knik Arm.

The primary constituent elements identified in the Proposed Critical Habitat Rule as "essential to the conservation of Cook Inlet beluga whales" are:

- Intertidal and subtidal waters of Cook Inlet with depths <30 feet (MLLW = Mean Lower Low Water) and within 5 miles of high and medium flow anadromous fish streams.
- Primary prey species consisting of four (4) species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole.
- The absence of toxins or other agents of a type or amount harmful to beluga whales.
- Unrestricted passage within or between the critical habitat areas.
- The absence of in-water noise at levels resulting in the abandonment of habitat by Cook Inlet beluga whales." (74 FR 63095, December 2, 2009)

Local Records: Population estimates by NMFS for the Cook Inlet beluga whale have totaled fewer than 400 individuals during the period 2001-2010; the 2010 estimate is 340 individuals (NMFS 2010b). Individuals/groups are seasonally common in Knik Arm waters adjacent to JBER from May to November. Cook Inlet belugas seasonally concentrate at mouths of anadromous fish streams where they feed on Pacific salmon (five species) and Pacific eulachon.

Other diet items include cod, pollock, and sole. In Knik Arm, belugas transit between locations such as stream mouths (NMFS 2010c) where behaviors including milling, feeding, and socializing by belugas have been identified (Stewart 2010). In the project area these areas include Six Mile Creek, North Eagle Bay, Eagle River, and near Point McKenzie, with transit of belugas primarily along the east side of the Lower Knik Arm (Stewart 2010). Most beluga activity in Knik Arm is noted during August, September, and October, coinciding with the Coho salmon run (NMFS 2010b). Within Knik Arm, beluga abundance is highly variable. Fourteen years of aerial surveys conducted during the first weeks of June by NMFS show beluga abundance in Knik Arm ranging from 224 (in 1997) to 0 whales (in 1994 and 2004) (NMFS 2008a). Beluga abundance in the Knik Arm is highest during the months of August through November, which account for 90 percent of observations of whales in the Knik Arm made by land and boat-based observations between July 2004 and July 2005 (NMFS 2010b). Surveys conducted by boat during August through October 2004 reported variable abundance counts in Knik Arm with 5-130 whales in August, 0-70 whales in September, and 0-105 whales in October (Funk et al. 2005). (Single observation totals of up to 71 whales during daily visits were recorded during summer 2009 in Eagle Bay at the mouth of Eagle River on JBER-Richardson (C. McKee, personal communication, USARG-DPW). Average daily visits to Eagle Bay were 9 whales (McKee and Garner 2010). These animals are expected to pass by JBER shorelines. Public observations suggest occasional feeding activity near mouth of Six Mile Creek, which is supported by studies conducted by Funk et al. (2005) and Stewart (2010.) The waters of Knik Arm are extremely turbid and subject to wide tidal fluctuations, with a mean diurnal range of 30 feet in Anchorage resulting in currents ranging from about 3 knots to 12 knots locally (Blackwell and Greene 2002). Belugas ascend to upper Knik Arm on the flooding tide and often retreat to lower portions of the Arm during low tides. In the narrows of the lower reaches of Knik Arm they tend to follow the tide within 1 km of either shoreline. Above the narrows, they may travel up the east side of the Knik Arm following the channel along Eagle Bay on incoming tides and belugas are observed to hug the western shoreline when moving out of the Knik Arm (NMFS 2010b); however, from vantage points on the east side of the Arm above the narrows, many of the same individuals observed swimming up on the east side are also observed to swim down on the same side (Garner, personal communication 2011).

1.5.2 Steller Sea Lion, Western DPS

Biology: See "National Marine Fisheries Service. 2008. Recovery Plan for the Steller Sea Lion (*Eumetopias jubatus*). Revision. National Marine Fisheries Service, Silver Spring, MD. 325 pages."

Status: Endangered (1997) (62 FR 24345, 62 FR 30772).

Critical Habitat: Designated August 27, 1993 (58 FR 45269) – none in Upper Cook Inlet.

Local Records: Steller sea lions have been observed in Knik Arm on rare occasions – most recently a single male was observed during summer of 2009 near the mouth of Eagle River, adjacent to Eagle River Flats (C. McKee, personal communication, JBER USARG-DPW). NMFS (2010b) indicates that there is little likelihood that the species would enter the Knik Arm in the vicinity of JBER in the future.

1.5.3 Steller's Eider, Alaska Breeding Population

Biology: See "U.S. Fish and Wildlife Service. 2003. Steller's Eider Recovery Plan. Fairbanks, Alaska. 29 pages."

Status: Threatened (1997) (62 FR 31748 31757).

Critical Habitat: Designated 2001 (66 FR 8849 8884) – none in Upper Cook Inlet.

Local Records: Steller's eider noted as a casual visitor to Anchorage area in Anchorage Audubon bird checklist suggesting less than 10 total records. USFWS (2010d) indicates the distribution during winter and migration includes the shorelines of Cook Inlet, below Knik Arm.

1.5.4 Yellow-billed Loon

Biology: See "USDI Fish and Wildlife Service. 2009b. Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition to List the Yellow-Billed Loon as Threatened or Endangered. 150 pp."

Status: Candidate –Priority 8 (2009) (74 FR 57803 57878).

Critical Habitat: None designated.

Local Records: Unsubstantiated observation on Green Lake, JBER during 2001 by A. Richmond. Not listed on Anchorage Audubon Bird Checklist.

1.5.5 Kittlitz's Murrelet

Biology: See "Alaska Seabird Information Series. 2006 Available at
http://alaska.fws.gov/mbsp/mbm/seabirds/pdf/kimu.pdf. Also: "Draft Spotlight Species Action Plan" U.S. Fish and Wildlife Service. August 4, 2009 Available at:
http://alaska.fws.gov/fisheries/endangered/pdf/kittlitzs_murrelet_draft_plan.pdf
http://ecos.fws.gov/docs/candforms_pdf/r7/B0AP_V01.pdf and: Birdlife International Fact Sheet. Available at: http://www.birdlife.org/datazone/speciesfactsheet.php?id=3310

Status: Candidate–Listing Priority 2 (2008) (74 FR 57803 57878).

Critical Habitat: None designated.

Local Records: Most of Cook Inlet, including Knik Arm, is outside areas identified as nesting areas, non-breeding concentrations, and breeding concentrations (U.S. Fish And Wildlife Service Species Assessment And Listing Priority Assignment Form**.** May 2010. Available at**:** http://ecos.fws.gov/docs/candforms_pdf/r7/B0AP_V01.pdf, information current as of May 2010).

1.5.6 Northern Sea Otter—Southwest Alaska DPS

Biology: See Southwest Alaska DPS of the Northern Sea Otter (*Enhydra lutris kenyoni*) Draft Recovery Plan (August 2010) available at http://alaska.fws.gov/fisheries/mmm/seaotters/pdf/draft_sea_otter_recovery_plan_small_file.pdf

Status: Threatened.

Critical Habitat: Designated critical habitat exists in the west side of the lower Cook Inlet (outside the project area): (http://alaska.fws.gov/fisheries/mmm/seaotters/pdf%5CSeaOtterCriticalHabitatMaps.pdf)

Local Records: This species is not known to occur in the Upper Cook Inlet including Knik Arm (USFWS 2004). The project area is outside designated Critical Habitat for the Northern Sea Otter southwest Alaska DPS. Unit 5 (Kodiak, Kamishak, Alaska Peninsula) of Designated Critical Habitat is present on the western side of the lower Cook Inlet as far north as Redoubt Point, which is well to the south of Knik Arm. (http://alaska.fws.gov/fisheries/mmm/seaotters/pdf%5CSeaOtterCriticalHabitatMaps.pdf).

1.6 Effects Analysis

1.6.1 Cook Inlet Beluga Whale

Potential effects to Cook Inlet beluga whales include potential behavioral responses to the overflight of F-22s. Animals may react to the sound of the jet aircraft or the visual stimulus of the aircraft being overhead by avoiding the area or altering their natural behavior patterns, which could constitute behavioral harassment. Beluga whales are known for the variety of their vocalizations and have good hearing sensitivity at medium to high frequencies (see Appendix 2). The following analysis and discussion focuses on the potential effects on belugas from overflight by F-22s.

The additional F-22s associated with the proposed Plus-Up would contribute an approximate 21 percent increase in F-22 sorties from JBER. Approaches and departures would follow previously established and defined approach and departure patterns from JBER that are currently in use by F-22s. The action area for this analysis encompasses portions of the Knik Arm that are overflown by F-22 aircraft on established approach, departure, and reentry patterns. These portions of Knik Arm are located to the west and north of JBER runways. Figures 2 through 8, presented in Section 1.6.1.2 below, encompass the Action Area. A detailed analysis of noise associated with F-22 sorties following these patterns has been conducted for this assessment and is presented in Appendix 1. Some background information and a summary of the analysis are provided here.

1.6.1.1 Aircraft Overflight Noise Background

Sound is transmitted from an airborne source to a receptor underwater by four principal means:

(1) Direct path, refracted upon passing through the air-water interface;

(2) Direct-refracted paths reflected from the bottom in shallow water;

(3) Lateral (evanescent) transmission through the interface from the airborne sound field directly above; and

(4) Scattering from interface roughness due to wave motion.

Aircraft noise is chiefly transmitted from air into the water within a narrow band centered on the flight path. A large portion of the acoustic energy is reflected from the air-water interface during transmission of sound from air to water. For an overhead sound source such as an aircraft much of the sound at angles greater than 13 degrees from the vertical is reflected and does not penetrate the water. The area of maximum transmission can therefore be visualized as a 13-degree cone (26-degree aperture) with the aircraft at its apex (see Figure 1). Aircraft will be audible for longer as they climb and the base of the cone increases, however the acoustic energy reaching the water surface diminishes with increasing altitude of the aircraft. Outside the conical area of maximum transmission, sound may be reflected back into the air or transmitted shallowly into the water where it stays near the surface, but could be heard by an animal on or near the surface outside the cone.

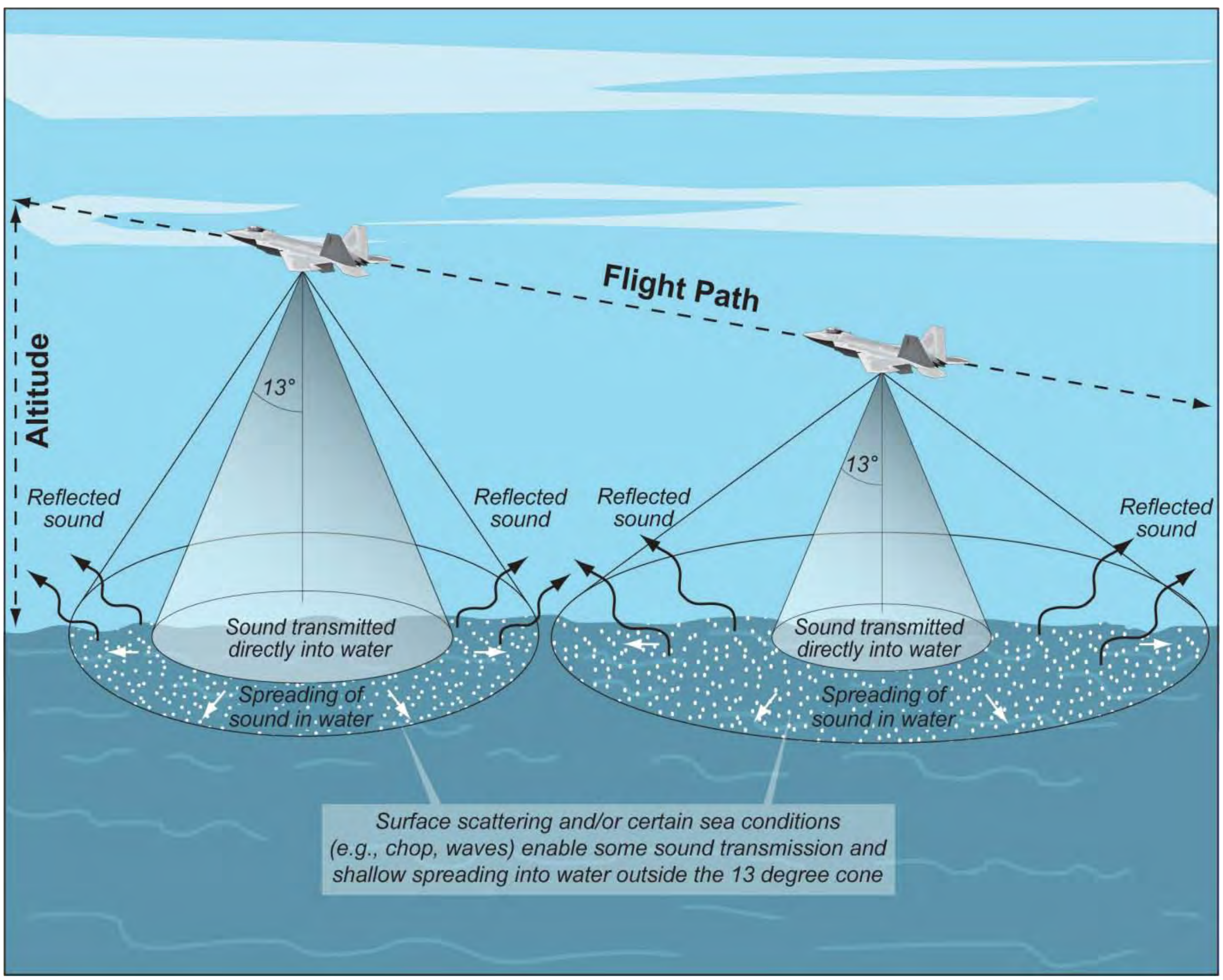


Figure 1. Aircraft noise transmission into water

Most sound is actually transmitted to water within the 13-degree "cone", especially in calm conditions. Outside the cone most sound is reflected except where appropriately oriented faces of waves and chop enable some sound to be transmitted across the air-water interface. The sound that penetrates outside the cone does not penetrate deeply. The analysis conducted for this project described in Appendix 1 and below treats the area ensonified as if the cone didn't exist. This simplifying assumption results in an overstatement of the amount of noise transmitted into the water from the air-water interface and results in an overestimation of the area affected by elevated noise levels in the water.

Exposures to elevated noise levels from aircraft overflight would be brief in duration (seconds) as the aircraft passes overhead and would diminish rapidly due to the speed of the aircraft. For example, Blackwell and Greene, in their study of underwater noise in the Cook Inlet near Elmendorf AFB (2002, Figure 3C), found that a landing F-15 passing directly overhead only generated underwater noise levels exceeding the ambient noise level for approximately three seconds. The exposed animal would need to be nearly directly underneath the overflight in order to be exposed to elevated noise levels from an aircraft overflight due to lack of or greatly diminished transmission of sound into water at angles greater than 13 degrees from the vertical. Furthermore, a noise would generally need to be louder than ambient (background) noise levels in order to be perceived by the animal.

Blackwell and Greene (2002) also measured high ambient noise levels in the Knik Arm. They found a 119 dB re 1 µPa average in-water reading adjacent to Elmendorf AFB while no overflights were taking place. The same investigators measured ambient noise of 124 dB re 1 µPa at Point Possession (a nearby locality south of Anchorage) during a changing tide. An EA for the Port of Anchorage reported noise levels on shipping days averaged 134–143 dB re 1 µPa and the Knik Arm Bridge EIS (Underwater Measurements of Pile-Driving Sound) reported background levels of 115–133 dB re 1 µPa. Additionally, KABATA *et al*. (2010) summarized a variety of existing noise studies conducted within the Knik Arm and concluded that measured background levels rarely are below 125 dB re 1 µPa, except in conditions of no wind and slack tide. Ambient noise energy in the Knik Arm is typically concentrated at frequencies below 10 kHz (Blackwell and Greene 2002).

Of F-15 aircraft overflights measured in air and in water while on approach for landing at Elmendorf AFB by Blackwell and Greene (2002), the sounds of overflight were detectable in water in only two of the eleven overflights, one at 90 degrees (i.e., directly overhead) and one at 80 degrees overhead. The peak in-water noise measured was 134dB re 1 µPa for the F-15 landing straight overhead; the second measured overflight (at 80 degrees overhead) was 122 dB re 1 µPa. The sounds from the remainder of the overflights could not be detected in the water. The authors attributed this to two factors, angles exceeding 13 degrees from vertical, which reduces penetration of sound energy into the water, and high ambient in-water noise. For those events where aircraft noise was detectable in the water, it was only detectable for approximately 3 seconds.

F-22 aircraft have been based at JBER since 2007, when F-22s replaced the F-15E and one of the F-15C squadrons that had been based at JBER. In 2010, the last remaining F-15 squadron departed JBER, leaving the F-22 as the only fighter aircraft based at JBER. F-22 engines are more powerful than those used in F-15 aircraft, and have the potential to be louder than engines of

F-15C or F-15E aircraft that had been present at Elmendorf AFB at the time the measurements by Blackwell and Greene (2002) described above were made. However, two operational factors reduce the differences in noise levels between the two aircraft types with regard to overflight of the Knik Arm under normal circumstances. These are: (1) faster rate of climb of the F-22, causing it to be at higher altitude when it overflies the Knik Arm during departures and (2) lower power settings required by the F-22 than for the F-15 on approach and when landing. It is interesting to note that in-water F-15 noise levels reported in the Blackwell and Greene study are only slightly less than estimated in-water F-22 noise levels predicted in this analysis (see Appendix 1). This result fits expectations given the characteristics of the two aircraft. Jet aircraft noise, which is generated primarily by turbulent mixing of air, is concentrated in relatively low frequency bands, primarily below 4,000 Hz (= 4 kHz – Wyle Labs 2001, see also Appendix 1, Figure 2). Spectral characteristics of F-22 noise in water have not been measured, but are expected to be similar to dominant ambient noise sources in the Knik Arm.

1.6.1.2 Potential Overflight Effects

The additional F-22 overflights would produce airborne noise and some of this energy would be transmitted into the water. Cook Inlet beluga whales could be exposed to noise associated with the additional F-22 overflights while at the surface or while submerged. In addition to sound, marine mammals could react to the shadow of a low-flying aircraft.

Exposure to F-22 aircraft noise would be brief (seconds) as an aircraft quickly passes overhead. Most observations of cetacean responses to aircraft overflights [(e.g., diving, slapping the water with flukes, swimming away from track of low-flying survey aircraft (Richardson *et al*. 1995)] are from aerial scientific surveys that involve aircraft flying at relatively low altitudes (frequently below 200 ft. MSL) and low airspeeds, often with repeated passes or circling. It should be noted that most of the aircraft overflight exposures analyzed in the studies reviewed by Richardson *et al*. (1995) are different than F-22 overflights. Compared to F-22s overflying the Knik Arm while approaching or departing from JBER, survey and whale watching aircraft are expected to fly at lower altitudes and exposure durations would be longer for aircraft intending to observe or follow an animal or group of animals.

The visual aspect of an F-22 overflight over the Knik Arm would be minimal, because of its altitude, small size, and rapidity of the overflight. The F-22's closest approach to the water surface ranges from 653 to 4295 feet MSL, depending on the flight procedure being conducted (data in Appendix 1, Table 1). Based on the annual use of the different flight paths, the weighted average of closest approach to water is 2,250 feet MSL for all flight paths.

As reported by F-22 pilots during interviews, airspeeds when crossing the Knik Arm range from 160 to 350 knots. Reported airspeeds were used to calculate time spent over Knik Arm in configurations that generate >120 dB SPL. The total time per flight event in flight configurations that result in underwater noise levels >120 dB SPL over the Knik Arm is between 26 and 163 seconds with the number of seconds depending on the flight procedure being conducted. Due to the F-22's airspeed, at any given point within the overflown portion of Knik Arm, exposures to underwater noise levels >120 dB SPL would be very brief—in the neighborhood of 2-5 seconds. Consecutive overflights (e.g., "two-ship" departures) could cause the period of exposure to noise level >120 dB SPL to be longer (e.g., up to about 10 seconds).

The visual experience of an F-22 overflight would be similar to that of an F-15 overflight. The F-22 is 62 ft long with a 44-foot wingspan and is similar in size to an F-15C or F-15E. Altitude profiles for the two aircraft are similar during arrival operations. During departure operations, the F-22 climbs more quickly than the F-15, resulting in the F-22 being at higher altitudes while overflying the Knik Arm. Airspeeds in the runway vicinity are similar for the two aircraft meaning that the duration of the visual experience is similar. Because of its altitude, small size, and rapidity of the overflight, adverse visual behavioral response to F-22 overflight on established flight tracks over Knik Arm is not expected.

A variety of effects may result from exposure to sound-producing activities. The severity of these effects can vary greatly between minor effects that have no realizable cost to the animal, to more severe effects that may have lasting consequences. Potential acoustic effects to marine mammals fall into five major categories: 1) Direct Trauma; 2) Auditory Fatigue; 3) Auditory Masking; 4) Stress Response; and 5) Behavioral Reactions.

Direct trauma refers to injury to organs or tissues of an animal as a direct result of an intense sound wave or shock wave impinging upon or passing through their body. This has only been shown with close proximity to very intense sources such as explosions. Auditory fatigue may result from overstimulation of the delicate hair cells and tissues within the auditory system. The maximum sound pressure level predicted within the water is 137dB re 1 μPa for a duration of a few seconds (see noise modeling calculations below and in Appendix 1). A temporary hearing loss (temporary threshold shift [TTS]) threshold of 195 dB re 1 μPa^2-s is primarily based on the cetacean TTS data from Schlundt et al. (2000) and corroborated by the short-duration tone data of Finneran et al. (2001, 2003, 2005) and the long-duration sound data from Nachtigall et al. (2003a, b). This is the best threshold to predict temporary hearing loss for non-impulsive sound, which is the lowest order direct physiological effect (with the exception of stress). An animal would need to be exposed to 137 dB re μPa continuously for about 175 hours to reach the 195 dB re 1 μPa^2-s sound exposure level threshold. Therefore direct trauma and auditory fatigue as a result of F-22 overflights are not predicted.

Auditory masking occurs when the perception of a sound is interfered with by a second sound and the probability of masking increases as the two sounds increase in similarity and the masking sound increases in level. The maximum predicted in-water sound from F-22 overflights is 137 dB re 1 μPa for a duration of a few seconds; during most flight operations and in most places under the flight path the maximum noise levels would be significantly less. As described above, ambient noise levels in the northern Cook Inlet and Knik Arm normally exceed 120 dB re 1 μPa. Therefore, since predicted F-22 overflight noise levels are often very close to ambient noise levels, and the noise would only be heard for a few seconds at any given point within the water, masking is not predicted.

Physiological stress and behavioral reactions may occur at the predicted in-water sound levels. The data to predict physiological stress based on specific sound levels do not exist for marine mammals. Therefore, the following analysis examines the possibility that F-22 overflights will cause a behavioral reaction (and possible physiological stress response) in Cook Inlet beluga whales. An analytical model was used to quantify potential behavioral disturbances based on predicted sound levels; thresholds derived from reactions of animals to similar intermittent, non-impulsive sounds; and Cook Inlet beluga whale density estimates. The most appropriate acoustic threshold is currently the odontocete risk function which assesses the probability of a behavioral reaction from 120 dB SPL to 195 dB SPL for non-pulse sound as described in Appendix 1. The results of this model were studied and a number of contextual factors were considered to ascertain the potential effects of F-22 overflights on the beluga whales.

As described in Appendix 1, all established flight profiles used by F-22s at JBER were modeled, taking into account engine power settings, altitudes, and maneuvers at points along each flight track. These parameters were verified with F-22 pilots at JBER through interviews and follow-up questions during the week of 6 December 2010. Each of the flight profiles consists of multiple segments (i.e., initial approach to the airfield, circling to land, etc.). Each flight profile segment that overflies the Knik Arm was assessed for potential to impact beluga whales. Noise levels in air were calculated at increments along each flight path. Appropriate conversions were made to account for the transmission of sound across the air/water interface as described in Appendix 1 and the maximum in-water sound pressure levels associated with overflights were calculated. As stated above, maximum modeled in-water sound pressure levels (SPL) associated with F-22 overflight of the Knik Arm do not exceed 137 dB re 1 μPa (Appendix 1).

The threshold for potential effects was then established using the odontocete risk function, an "S"-shaped curve which assesses the probability of a behavioral reaction in the interval between 120 dB SPL to 195 dB SPL for non-pulse sound (see Appendix 1, page 2, and Appendix 1, Figure 1). The odontocete risk function as applied in this analysis was designed based on findings of several studies, including numerous individuals, and therefore takes into account variation among individuals in sensitivity to stimulus. Highly sensitive individuals (or groups) would have a slightly higher likelihood of behavioral response than indicated by the odontocete risk curve at a given received level and unusually insensitive individuals would have a slightly lower likelihood of behavioral response than indicated by the odontocete risk curve. Given this threshold range, all areas in which modeled in-water SPL exceeds 120 dB re 1 μPa at the loudest point were delineated and broken down into subareas or "bins" within which in-water SPLs ranged from 120-125 dB; 125-130 dB; and above 130 dB re 1 μPa, respectively. These were mapped for each type of flight path and their areas determined using GIS. The affected area was then multiplied by a value estimating beluga population density. We considered two density values, 0.08 beluga whales/km^2 and 0.12 beluga whales/km^2, and ultimately used the higher density in our calculations because it would yield a higher estimate of effect. The smaller value (0.08 beluga whales/km^2) was the maximum monthly density of belugas calculated for the Knik Arm near JBER based on several monitoring studies (KABATA *et al.* 2010, Table 8). The larger density value was based on the current (2010) estimated Cook Inlet beluga whale population of 340 individuals (NMFS 2010b) divided by 2,800 km^2, the area estimated to represent 95 percent of the occupied Cook Inlet beluga whale range (Rugh *et al.* 2010), thus yielding a density estimate of 0.12 beluga whales/km^2.

The results are shown in Figures 2 through 8, which portray all flight profiles in which in-water SPLs were calculated to equal or exceed 120 dB. The F-22 flight profiles depicted in Figures 2 through 8 are named according to five character codes which are sometimes followed by a number (e.g. RAPTR, EEEGL2, and MATSU5) or according to the type of pattern being conducted (e.g., IFR approach, VFR re-entry). The legend of each figure contains the probability of behavioral effect, determined for the highest SPL in the range (e.g., 125 dB for the range 120-125 dB). For areas exceeding 130 dB SPL, the maximum probability of behavioral reaction from the odontocete risk function for the probability associated with 137 dB SPL was used. This was the highest modeled exposure for any flight path.

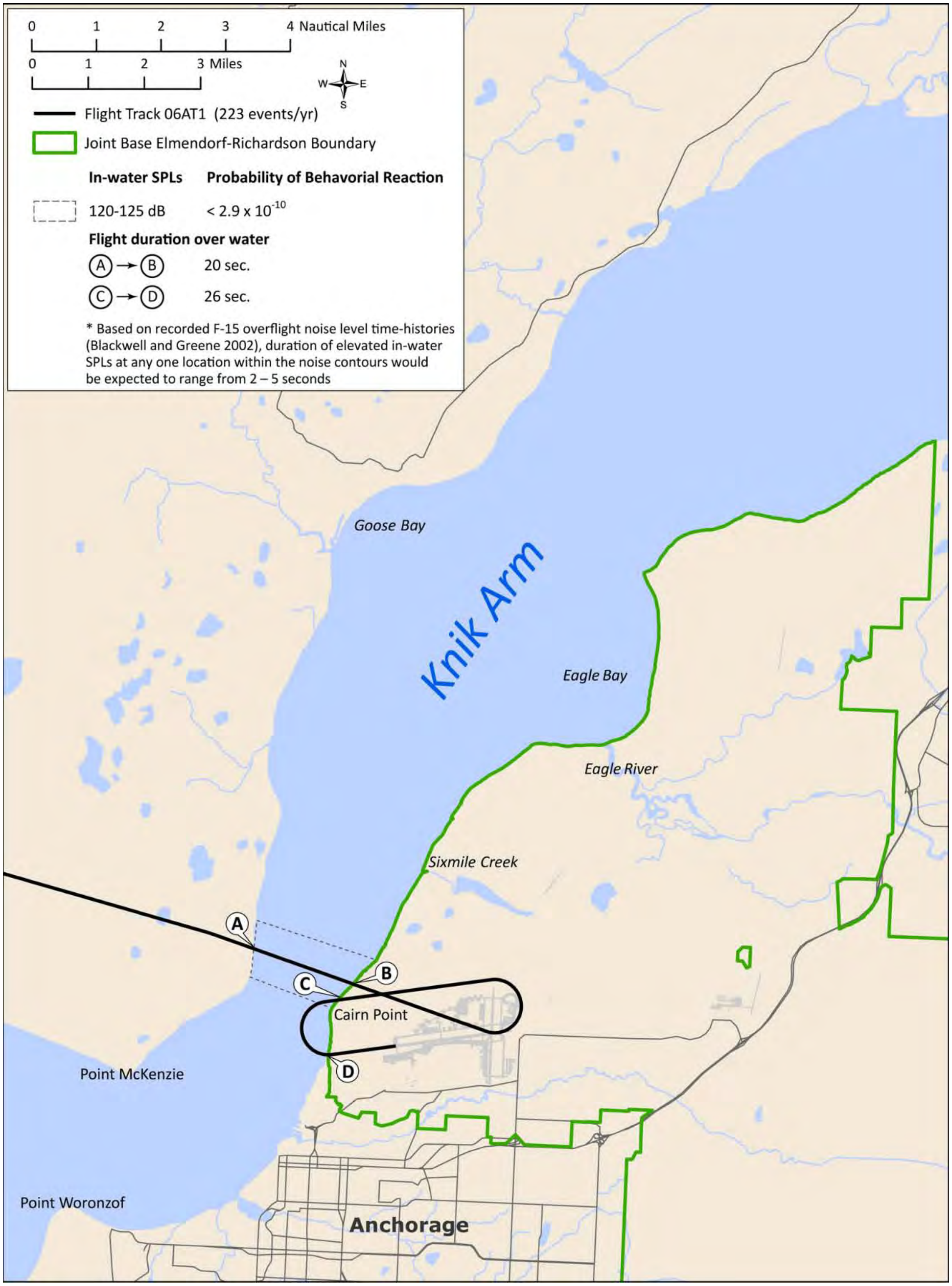


Figure 2. Water Surface Area Below Which Modeled Instantaneous In-Water Sound Pressure Levels Are 120 dB or Greater Resulting From F-22 Overflight on RAPTR Transition to Runway 06, Flight Lead (Track 06AT1), Initial Approach to Runway.

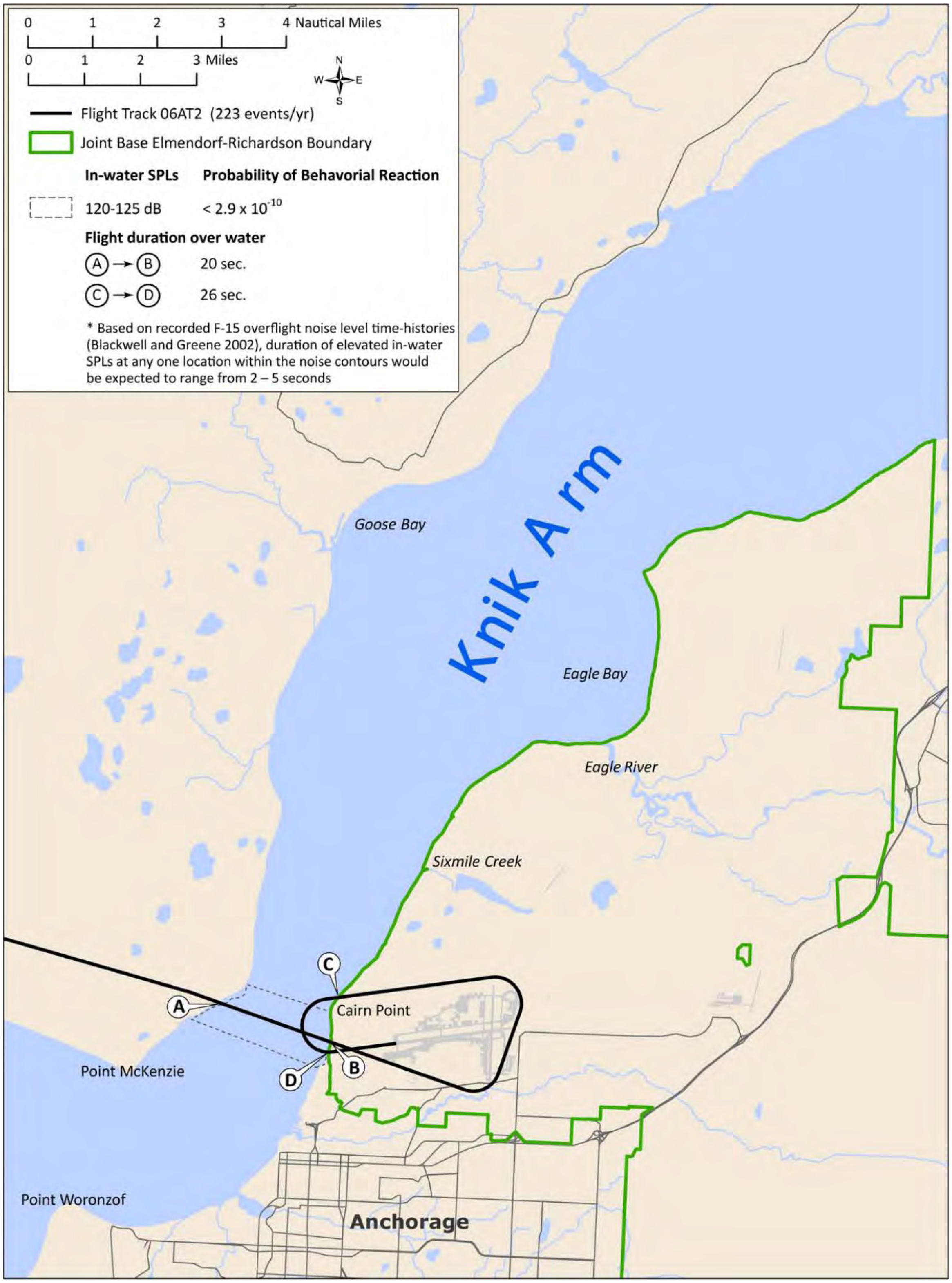


Figure 3. Water Surface Area Below Which Modeled Instantaneous In-Water Sound Pressure Levels Are 120 dB or Greater Resulting From F-22 Overflight on RAPTR Transition to Runway 06, Wingman (Track 06AT2), Initial Approach to Runway.

Figure 4. Water Surface Area Below Which Modeled Instantaneous In-Water Sound Pressure Levels Are 120 dB or Greater Resulting From F-22 Overflight on IFR Approach to Runway 06 (Track 06AT3), Arrival or Closed Pattern.

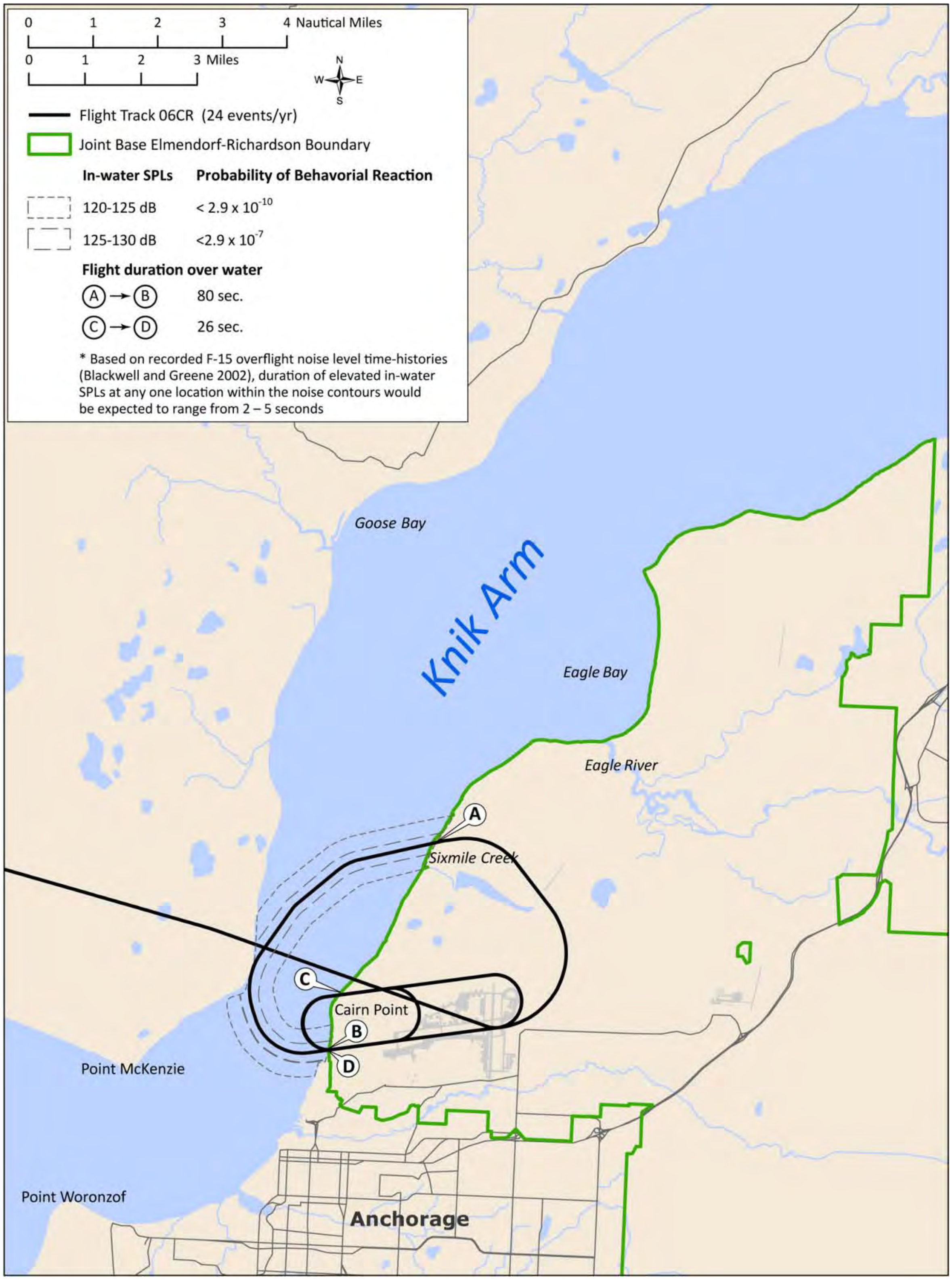


Figure 5. Water Surface Area Below Which Modeled Instantaneous In-Water Sound Pressure Levels Are 120 dB or Greater Resulting From F-22 Overflight on VFR Re-entry Pattern to Runway 06 (Track 06CR), Initial Approach to Runway.

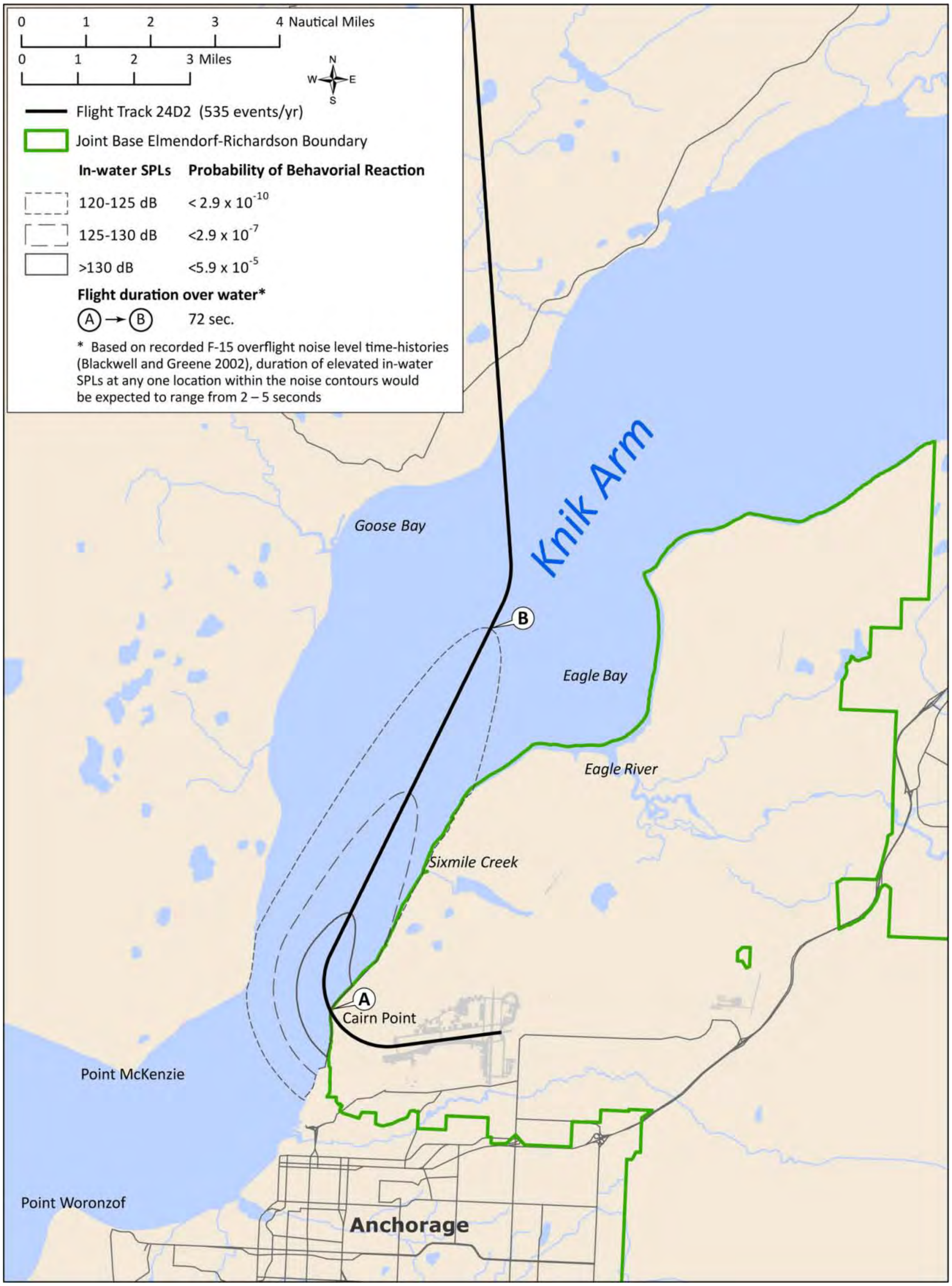


Figure 6. Water Surface Area Below Which Modeled Instantaneous In-Water Sound Pressure Levels Are 120 dB or Greater Resulting From F-22 Overflight on EEEGL2 Departure from Runway 24 (Track 24D2), Military or Afterburner Departure.

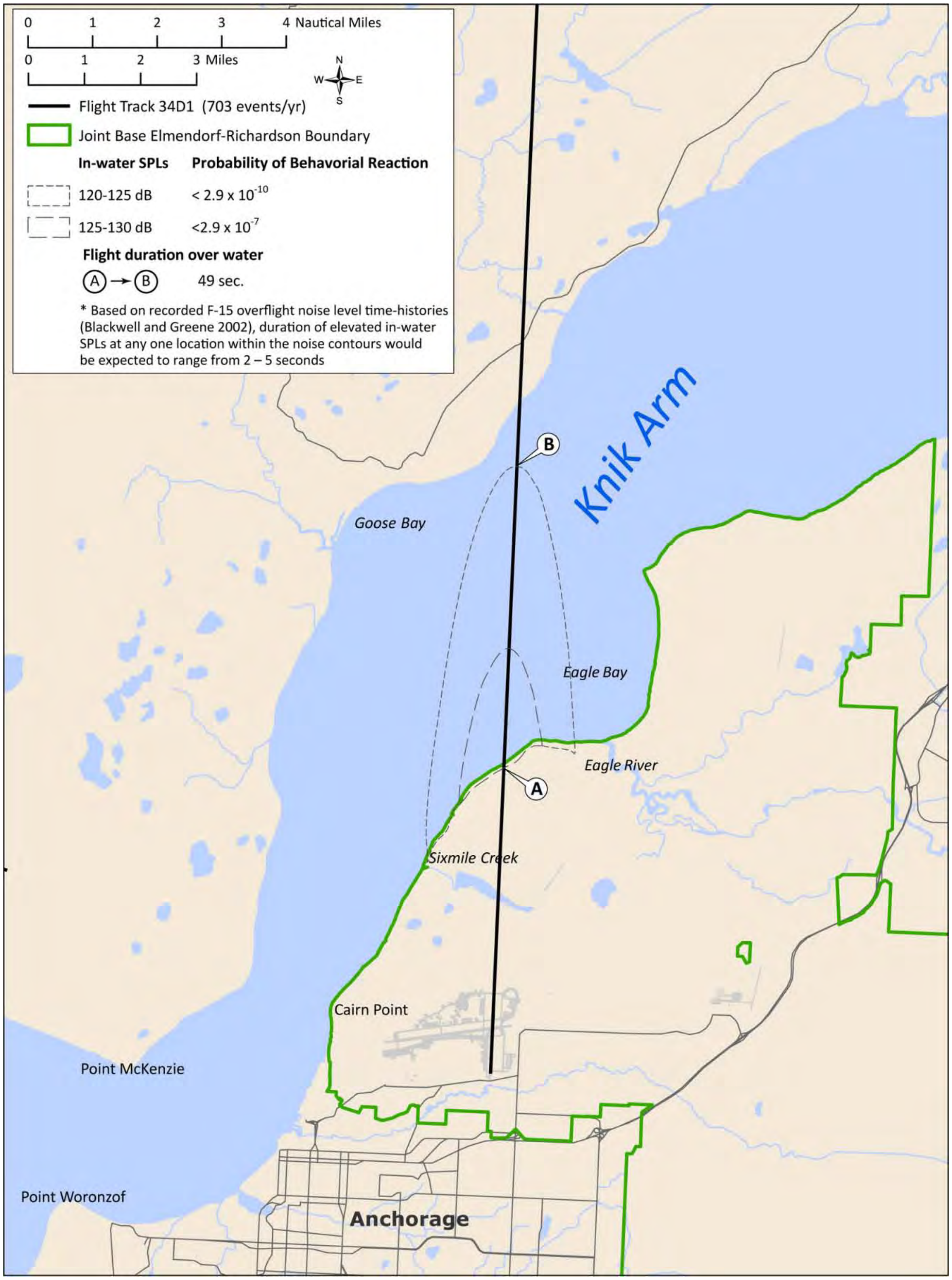


Figure 7. Water Surface Area Below Which Modeled Instantaneous In-Water Sound Pressure Levels Are 120 dB or Greater Resulting From F-22 Overflight on EEEGL2 Departure from Runway 34 (Track 34D1), Military Departure.

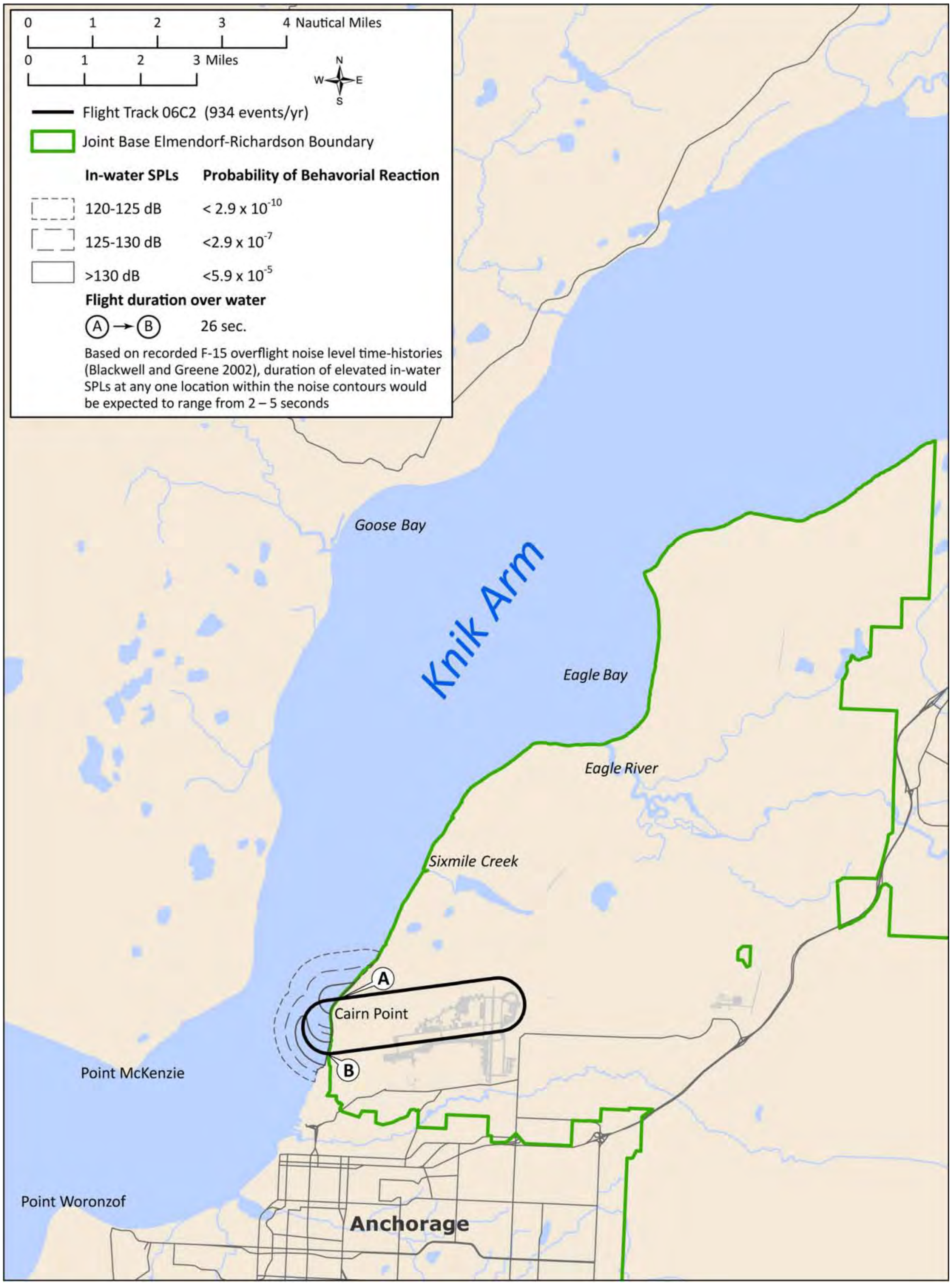


Figure 8. Water Surface Area Below Which Modeled Instantaneous In-Water Sound Pressure Levels Are 120 dB or Greater Resulting From F-22 Overflight on Overhead Pitch or Visual Closed Pattern to Runway 06 (Track 06C2).

As detailed in Appendix 1, the analysis was again conservative (i.e., overestimates effects), calculating the largest possible footprint of sound levels exceeding 120 dB. Much of the noise energy generated by jet aircraft is at low frequencies (below 10 kHz), which is below the best hearing range of belugas (30-80kHz). Overflights generally occur over portions of the lower Knik Arm where beluga whales are generally transiting when present (KABATA et al., 2010). The probability and consequences of altering a transiting animal's behavior are unknown, however biologically significant effects would be less likely than those associated with disturbing feeding or mating behavior. However, modeled noise levels of 120-125 dB associated with some flight tracks are predicted in the vicinity of the mouth of Six Mile Creek (Figures 5-7) and Eagle Bay (Figure 7), areas where belugas are known to feed and congregate. Given the regular occurrence of overflight of belugas by jet aircraft at Stevens International Airport and JBER, the brief duration of the exposure to elevated in-water noise (seconds, as described above), and the absence of direct physical harm or injury to belugas from overflight, there is potential for diminution of any behavioral response to overflight over time (habituation). Blackwell and Greene (2002) indicated this appears to be the case with belugas, which are thought to habituate and become tolerant of the vessels, when exposed to substantial boat traffic. Additionally, for animals to detect and respond to a noise it needs to be louder than background by greater than a value known as the critical ratio. Odontocete critical ratios are typically between 10 and 20 dB, with the actual value varying by frequency and species (Richardson *et al.* 1995). Given that measured in-water noise levels in the Knik Arm near JBER are frequently in the neighborhood of 120-125 dB re 1 µPa or more (NMFS 2010b; Blackwell and Greene 2002), it is possible that elevated in-water noise from overflights would not be perceived as a distinct noise source by the belugas because of the high levels of ambient in-water noise. The high levels of ambient noise are not accounted for in the analytical approach employed in this document (see Appendix 1) and this is another factor that may result in overestimation of the likelihood of behavioral reaction to overflights.

The resulting estimated number of behavioral reactions associated with the proposed action are less than 0.04 individuals per year (Appendix 1). Because the likelihood of behavioral reaction is essentially zero, it is so low as to be discountable and it is therefore concluded that the project may affect but is unlikely to adversely affect the Cook Inlet beluga whale.

The potential for project effects on the proposed critical habitat for Cook Inlet beluga whale was evaluated as summarized below with respect to the five Primary Constituent Elements (PCEs) in the proposed critical habitat (74 FR 63095, December 2, 2009). The PCEs are listed above in Section 1.5.1 of this report.

(1) Because there would be no onshore or in-water construction, earth moving, or vegetation removal associated with the proposed F-22 plus-up, there would be no effects on the water quality or hydrology of waters of the Knik Arm or its tributaries.

(2) Overflights by additional F-22s, including elevated sound levels, are not expected to affect prey species consumed by Cook Inlet beluga whales. In the Knik Arm project area, these primarily include four salmon species and Pacific eulachon; however Pacific cod, walleye pollock, saffron cod, and yellowfin sole are also taken. Salmon and most marine fish are hearing generalists with their best hearing sensitivity at low frequencies (below 300 Hz) where they can detect particle motion induced by low frequency sound at high intensities (Amoser and Ladich 2005; Popper and Hastings 2009), not

approached by projected sound levels associated with F-22 overflight. Studies of Atlantic salmon conclude that they are unlikely to detect sounds originating in air (Hawkins and Johnstone 1978). It is unlikely that the fish species listed as beluga prey would detect the noise from any jet overflights. If overflight sounds were detected by fish species, any effects would be short-term and minor, given the low projected sound pressure levels (maximum of 137 dB re 1 μPa), short duration, and intermittent nature of elevated in-water sound associated with F-22 overflight.

(3) There would be no introduction of toxins or other agents of a type or amount harmful to beluga whales.

(4) The project would not affect passage of beluga whales within or between critical habitat areas.

(5) Based on the analysis in this report, there would be "absence of in-water noise at levels resulting in the abandonment of habitat by Cook Inlet beluga whales."

Therefore the project is not expected to result in adverse modification of the proposed critical habitat for the Cook Inlet beluga whale.

In conclusion, although Cook Inlet beluga whales are likely to be present during some of the F-22 overflights, analysis of modeled underwater noise levels shows that exposure to projected in-water noise levels exceeding 120 dB re 1 μPa would be exceedingly unlikely to result in behavioral harassment. Therefore this proposal will have no indirect, cumulative or interdependent/interrelated effects in regards to Cook Inlet Beluga whale and would have no effect on its proposed critical habitat.

Determination: May affect not likely to adversely affect Cook Inlet Beluga Whale. No effect on Cook Inlet Beluga Whale proposed Critical Habitat, or its prey species.

1.7 Steller Sea Lion

(1) This species is not expected to occur in the project area (NMFS 2010b) and the combined likelihood of its occurrence in the project area and being in the area of elevated noise levels from F-22 overflight is so low as to be discountable.

(2) Therefore, this proposal will have no direct, indirect, cumulative or effect in regards to Western population of Steller sea lion or its habitat.

(3) Determination: May affect not likely to adversely affect Steller sea lion.

1.8 Steller's Eider

(1) This species is not expected to occur in the project area and the combined likelihood of its occurrence in the project area and being in the area of elevated noise levels from F-22 overflight is so low as to be discountable.

(2) Therefore, this proposal will have no direct, indirect, or cumulative effects in regards to the Alaska breeding population of Steller's eider.

(3) Determination: May affect not likely to adversely affect Steller's eider.

1.9 Yellow-billed Loon

(1) This species is not expected to occur in the project area and the combined likelihood of its occurrence in the project area and being in the area of elevated noise levels from F-22 overflight is so low as to be discountable.

(2) Therefore, this proposal will have no direct, indirect, or cumulative effects in regards to the yellow-billed loon.

(3) Determination: May affect not likely to adversely affect the yellow-billed loon.

1.10 Kittlitz's Murrelet

(1) This species is not expected to occur in the project area and the combined likelihood of its occurrence in the project area and being in the area of elevated noise levels from F-22 overflight is so low as to be discountable.

(2) Therefore, this proposal will have no direct, indirect, or cumulative effects in regards to Kittlitz's murrelet.

(3) Determination: May affect but not likely to adversely affect Kittlitz's murrelet.

1.11 Northern Sea Otter, Southwest Alaska DPS

(1) This species is not expected to occur in the project area and the combined likelihood of its occurrence in the project area and being in the area of elevated noise levels from F-22 overflight is so low as to be discountable.

(2) Therefore, this proposal will have no direct, indirect, or cumulative effects in regards Southwest Alaska DPS of the Northern Sea Otter.

(3) Determination: May affect but not likely to adversely affect the Southwest Alaska DPS of the Northern Sea Otter.

1.12 Conclusion

A determination of "may affect not likely to adversely affect" is found for all species analyzed; therefore, no Sec 7 consultation is required for this project.

1.13 Additional Considerations

1.13.1 Marine Mammal Protection Act (MMPA)

All marine mammals are protected under the Marine Mammal Protection Act. Because behavioral reactions by beluga whales are not predicted (< 1 behavioral reaction per year) there would be no harassment of this species under MMPA. Other marine mammal species occasionally documented in the Knik Arm Project Area include Steller's sea lion (discussed above), harbor seal (*Phoca vitulina*), harbor porpoise (*Phocoena phocoena*), and killer whale (*Orcinus orca*). Their occurrences are infrequent and in much lower abundance in the Knik Arm than the Cook Inlet beluga whales. Potential project effects identified above for the beluga whale are considered to be possible, but even less likely given the very low abundance of these species in the Knik Arm. Adverse effects associated with the proposed Plus-Up, including behavioral reactions to overflight, are not expected to occur for any marine mammal.

1.13.2 Migratory Bird Treaty Act (MBTA)

The Migratory Bird Treaty Act of 1918 (amended in 1936 and 1972) prohibits the taking of migratory birds, unless authorized by the Secretary of Interior. Executive Order 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds) provides for the conservation of migratory birds and their habitats, and requires the evaluation of the effects of Federal actions on migratory birds, with an emphasis on species of concern. Federal agencies are required to support the intent of the migratory bird conventions by integrating bird conservation principles, measures, and practices into agency activities and by avoiding or minimizing, to the extent practicable, adverse impacts on migratory birds when conducting agency actions. The DoD has an exemption of the MBTA for training for military readiness. Although not directly for this project, a permit for take exists and is maintained in the Bird Exclusion Zone on JBER.

1.13.3 National Environmental Policy Act (NEPA)

This wildlife analysis has been prepared in conjunction with an F-22 Plus-Up Environmental Assessment (EA) being prepared by the United States Air Force (Air Force) to evaluate the potential environmental consequences of the proposal to add six primary and one back-up F-22 aircraft to the Joint Base Elmendorf-Richardson (JBER) F-22 inventory, an increase in primary aircraft of approximately 17 percent.

1.14 Literature Cited

Alaska Department of Environmental Conservation. 2010. Construction General Permit for Stormwater. Available at: http://www.dec.state.ak.us/water/wnpspc/stormwater/sw_construction.htm.

Amoser, S. and F. Ladich. 2005. Are hearing sensitivities adapted to the ambient noise in their habitats? J. Experimental Biology 208:3533-3542.

Blackwell, S. B. and C. R. Greene, Jr. Acoustic Measurements in Cook Inlet, Alaska, During August 2001. Prepared by Greeneridge Sciences for National Marine Fisheries Service, Protected Resources Division, Anchorage AK. 12 August.

Eller, A. I. and R. C. Cavanagh. 2000. Subsonic Aircraft Noise At and Beneath the Ocean Surface: Estimation of Risk for Effects on Marine Mammals. Prepared by Science Applications International Corporation for United States Air Force Research Laboratory. Wright-Patterson AFB, OH. AFRL-HE-WP-TR-2000-0156.

Funk, D.W., T.M. Markowitz, and R. Rodrigues (eds.) 2005. Baseline studies of beluga whale habitat use in Knik Arm, Upper Cook Inlet, Alaska, July 2004-July 2005. Rep. from LGL Alaska Research Associates, Inc., Anchorage, AK, in association with HDR Alaska, Inc., Anchorage, AK, for Knik Arm Bridge and Toll Authority, Anchorage, AK, Department of Transportation and Public Facilities, Anchorage, AK, and Federal Highway Administration, Juneau, AK.

Hawkins, A. D. and A. D. F. Johnstone. 1978. The hearing of the Atlantic Salmon, *Salmo salar*. *J. Fish Biol*. 13:655-673.

KABATA (Knik Arm Bridge and Toll Authority) *et al*. 2010. Request for Letter of Authorization under Section 101(a)(5) of the Marine Mammal Protection Act Incidental to Construction of the Knik Arm Crossing Project in Upper Cook Inlet, Alaska. Submitted to Office of Protected Resources, National Marine Fisheries Service (NMFS), Silver Spring, MD 20910-3226 Submitted by: Knik Arm Bridge and Toll Authority, Anchorage, Alaska 99501; Alaska Department of Transportation and Public Facilities, Anchorage, Alaska 99501 and Federal Highway Administration, Juneau, Alaska 99802. Biological Consultant: HDR Alaska, Inc., Anchorage, Alaska. August 18.

McKee, C. and C. Garner. 2010. Cook Inlet Beluga Whale Monitoring Eagle Bay, Fort Richardson, Alaska 2008-2009. Presented 12 October 2010. In Cook Inlet Beluga Whale Science Conference, hosted by National Marine Fisheries Service, Alaska Region, Anchorage Downtown Marriott, Alaska, October 11 & 12, 2010. Available at: http://www.alaskafisheries.noaa.gov/protectedresources/whales/beluga/workshop/presentations/17_cib_monitoring_eaglebay.pdf

National Marine Fisheries Service (NMFS = NOAA Fisheries). 2008a. Conservation Plan for the Cook Inlet Beluga Whale (*Delphinapterus leucas*). National Marine Fisheries Service, Juneau, Alaska. 128 pp. Available at: http://www.alaskafisheries.noaa.gov/protectedresources/whales/beluga/mmpa/final/cp2008.pdf

_____. 2008b. Recovery Plan for the Steller Sea Lion (*Eumetopias jubatus*). Revision. National Marine Fisheries Service, Silver Spring, MD. 325 pp. Available at: http://www.fakr.noaa.gov/protectedresources/stellers/recovery/sslrpfinalrev030408.pdf

_____. 2009. Endangered and Threatened Species: Designation of Critical Habitat for Cook Inlet Beluga Whale. Proposed Rule. 50 CFR Part 226. Federal Register 74(230): 63080-63095. Available at: http://www.fakr.noaa.gov/prules/74fr63080.pdf

_____. 2010a. Letter dated January 5, 2010 - Threatened and Endangered Species Associated with Elmendorf AFB and Cook Inlet . United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Juneau, AK. 2 pp.

_____. 2010b. Biological Opinion, Endangered Species Act: Section 7 Consultation Biological Opinion. Knik Arm Crossing, Anchorage, Alaska. November 30, 2010. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Juneau, AK. 86 pp.

_____. 2010c. Proposed Critical Habitat for the Cook Inlet Beluga Whales. Presentation made at Public Hearings February, 2010. Available at: http://www.fakr.noaa.gov/protectedresources/whales/beluga/chabitat/phearingppt0210.pdf

Popper, A. N., and Hastings, M. C. (2009). The effects on fish of human-generated (anthropogenic) sound. Integrative Zool. 4:43-52.

Rugh, D.J., Shelden, K.W., Hobbs, R.C. 2010. Range Contraction in a Beluga Whale Population. Endangered Species Research. Vol 12: 69-75

Stewart, Brent S. 2010. Interactions between beluga whales (*Delphinapterus leucas*) and boats in Lower Knik Arm, Alaska: Behavior and Bioacoustics (1 August-14 September 2008. Presented 12 October 2010. In Cook Inlet Beluga Whale Science Conference, hosted by National Marine Fisheries Service, Alaska Region, Anchorage Downtown Marriott, Alaska, October 11 & 12, 2010. Available at: http://www.alaskafisheries.noaa.gov/protectedresources/whales/beluga/workshop/presentations/19_stewart_cib_bioacoustics.pdf

United States Air Force (Air Force). 2000. Explosives Safety Standards. Available at: http://www.fas.org/nuke/intro/aircraft/afman91-201.pdf. 213 pp.

_____. 2004. Integrated Natural Resources Management. Available at: http://www.e-publishing.af.mil/shared/media/epubs/AFI32-7064.pdf. 84 pp.

_____. 2006. F-22A Beddown Environmental Assessment, Elmendorf AFB, Alaska. June 2006.

United States Department of Interior Fish and Wildlife Service USFWS). 2003. Steller's Eider Recovery Plan. Fairbanks, Alaska. Available at: http://alaska.fws.gov/fisheries/endangered/pdf/Steller%27s%20Eider%20Recovery%20Plan.pdf 29 pp.

_____. 2004. Endangered and Threatened Wildlife and Plants; Listing the Southwest Alaska Distinct Population Segment of the Northern Sea Otter (*Enhydra lutris kenyoni*) as Threatened. *Federal Register* 69:6600-6621.

_____. 2007. The Steller's eider. Available at: http://alaska.fws.gov/fisheries/endangered/listing.htm. 2 pp.

_____. 2009a. Yellow-billed loon (*Gavia adamsii*). March 2009. Available at: http://alaska.fws.gov/fisheries/endangered/pdf/ybl_factsheet.pdf.

_____. 2009b. Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition to List the Yellow-Billed Loon as Threatened or Endangered. Available at: http://alaska.fws.gov/fisheries/endangered/pdf/2009-06012_PI.pdf 150 pp.

_____. 2010a. Letter dated January 13, 2010 – Elmendorf/Fort Richardson Renewal of Integrated Natural Resource Management Plan. United States Department of the Interior, Fish and Wildlife Service, Anchorage, AK. 1 pp.

_____. 2010b. Species profile: Kittlitz Murrelet (*Brachyramphus brevirostris*). Available at: http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0AP

_____. 2010c. Southwest Alaska Distinct Population Segment of the Northern Sea Otter (*Enhydra lutris kenyoni*) Draft Recovery Plan. Available at: http://ecos.fws.gov/docs/recovery_plan/101012.pdf

_____. 2010d. ESA Listed Species Consultation Guide—Anchorage Fish and Wildlife Field Office. Consulted December 20, 2010. Available at: http://alaska.fws.gov/fisheries/endangered/pdf/Consultation_guide_31010.pdf

Wyle Laboratories. 2001. Wyle Report 01-21 Status of Low-Frequency Aircraft Noise Research and Mitigation. September

Adapted from Wildlife Analysis Prepared by: Matthew Moran, GS-12, Wildlife Biologist, 611th CES/CEAN, JBER, AK, Herman Griese, YD-02, Wildlife Biologist, 673 CES/CEANC, JBER, AK, Brent A. Koenen, YF-02, Chief, Conservation & Planning, 673 CES/CEANC, JBER, AK, and Elizabeth E. Godden, YD-02, NEPA Coordinator, 673 CES/CEAO, JBER, AK, on 17 November 2010.

APPENDIX 1. NOISE IMPACTS ASSESSMENT METHODOLOGY AND QUANTITATIVE RESULTS

1.15 Introduction

This appendix describes a methodology for estimation of potential behavioral effects of Cook Inlet beluga whales (CIBW) associated with proposed increase in F-22 aircraft operations at Joint Base Elmendorf Richardson (JBER), AK associated with the addition of six primary aircraft and summarizes results of the analysis.

1.16 Methodology

The steps involved in predicting potential behavioral reactions are described below:

Step 1: Calculate Maximum *in-air* noise level associated with overflights. F-22 pilot interviews were held during the week of 6 December 2010 for the purpose of collecting detailed data on aircraft operations (i.e., engine power settings, altitudes, and airspeed at several points along each flight track). During the interviews, several flight profiles were developed which are representative of F-22 flying patterns at JBER. Each of the flight profiles consists of multiple segments (i.e., initial approach to the airfield, circling to land, etc.). Each flight profile segment that overflies the Knik Arm was assessed for potential to impact beluga whales. Event types were aggregated when the flight profile segment of two events were identical over the Knik Arm. For example, afterburner and non-afterburner departures are identical over the Knik Arm. Pilots turn off afterburner prior to reaching water and the altitude/power setting profiles and flight tracks describing these two event types are the same from that point onward.

Maximum A-weighted noise level reference 20 µPa (LA_{max} re 20 µPa) at sea level associated with each F-22 flight profile segment was calculated at the location over the Knik Arm where aircraft altitude is lowest. Calculations were made using the program SEL_CALC under median atmospheric noise propagation conditions at JBER (59° F and 71% R.H.). Variable weather conditions (e.g., wind direction, wind intensity, temperature profile, relative humidity) have a limited affect on received aircraft noise levels. For example, monthly average atmospheric sound absorption coefficients at JBER vary from median value by less than 1.3 dB per 1,000 feet. The term 'A-weighted' denotes adjustment of component frequency band sound pressure levels to reflect human hearing. Decibels are a way of expressing sound levels that involves the ratio of a sound pressure against a reference pressure level. By convention, sound levels in air are stated as referenced to 20 µPa.

Step 2: Calculate Maximum *in-water* noise level associated with overflights. The A-weighted noise levels re 20 µPa reported by SEL_CALC were converted to estimated un-weighted sound pressure levels (SPL) re 1 µPa. A-weighted and un-weighted F-22 aircraft noise levels from the NOISEMAP NOISEFILE database were compared for several F-22 aircraft configurations, and it was found that un-weighted noise levels were consistently 2.9 to 3.1 dB higher than A-weighted noise levels. Three dB were added to A-weighted noise levels to estimated un-weighted SPL. It should be noted that odontocete hearing is not strong at low frequencies (Southall *et al* 2007). Much of the noise energy generated by jet aircraft is at low frequencies, and use of un-weighted SPL yields conservative estimates of noise impacts to belugas. Transmission of sound from a moving airborne source to a receptor underwater is influenced by numerous factors and has been studied extensively (Richardson *et al.* 1995, Young 1973, Urick 1972). In this wildlife analysis, twenty-six dB were added to SPL re 20 μPa to convert to SPL re 1 μPa and, an additional 6 dB are added to account for doubling of sound pressure as the sound rays cross the interface between air and water. Taking into account sound metric conversion and the reflectance of noise energy at the air-water interface, noise levels in water (SPL re 1 μPa) were calculated as being 35 dB higher than noise levels in air just above the water's surface (LA_{max} re 20 μPa). Additional discussion on transmission of aircraft noise into water is located in 'Step 4: Establish area exposed to noise exceeding thresholds'.

Step 3: Establish threshold for potential effects. Calculated noise levels generated by F-22 aircraft in the Knik Arm do not exceed 137 dB SPL re 1 μPa, well below the threshold for temporary hearing loss (195 dB re 1 μPa^2-s) and permanent hearing loss (215 dB re 1 μPa^2-s) for non-pulse sound. However, such noise levels do have some probability of causing a behavioral reaction such as area avoidance or alteration of natural behaviors.

The most appropriate acoustic threshold is currently the odontocete risk function, which assesses the probability of a behavioral reaction from 120 dB SPL to 195 dB SPL for non-pulse sound (U.S. Navy 2008). The risk function was derived by the U.S. Navy and NMFS to determine effects from mid-frequency sonar. However, the odontocete risk function is currently the best available science for predicting behavioral effects from intermittent, non-impulsive (non-pulse) sound.

The risk function is used to estimate the percentage of an exposed population that is likely to exhibit behaviors at a given received level of sound (NOAA 2009, NMFS 2009). For example, at 165 dB SPL (dB re: 1 μPa rms), the risk (or probability) of harassment is 50 percent, and NMFS applies that 50 percent of the individuals exposed at that received level are likely to respond by exhibiting behavior that NMFS would classify as behavioral harassment (NOAA 2009, NMFS 2009).

The values used in the odontocete risk function are based on three sources of data: Temporary threshold shift (TTS) experiments conducted at Space and Warfare Systems Center (SSC) and documented in Finneran, et al. (2001, 2003, and 2005; Finneran and Schlundt 2004); reconstruction of sound fields produced by the USS SHOUP associated with the behavioral responses of killer whales observed in Haro Strait and documented in NMFS (2005), DoN (2004), and Fromm (2004a, 2004b); and observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components documented in Nowacek et al. (2004).

The risk function represents a general relationship between acoustic exposures and behavioral responses. The risk function, as currently derived, treats the received level as the only variable that is relevant to a marine mammal's behavioral response. However, we know that many other variables—the marine mammal's gender, age, and prior experience; the activity it is engaged in during an exposure event, its distance from a sound source, the number of sound sources, and whether the sound sources are approaching or moving away from the animal—can be critically important in determining whether and how a marine mammal will respond to a sound source (Southall et al. 2007). The data that are currently available do not allow for incorporation of these other variables in the current risk functions; however, the risk function represents the best use of the data that are available (NOAA 2009).

The odontocete risk function curve was adapted from Feller 1968 (Figure 3)

$$R = \frac{1 - \left(\frac{L - B}{K}\right)^{-A}}{1 - \left(\frac{L - B}{K}\right)^{-2A}}$$

Where: R = risk (0 – 1.0);

L = Received Level (RL) in dB;

B = Basement RL (i.e. lowest RL at which behavioral reaction possible) in dB;

K = the RL increment above basement in dB at which there is 50 percent risk;

A = Risk transition sharpness parameter

Feller function parameter values used in this analysis were selected in keeping with values used to predict behavioral reaction from non-impulsive noise to odontocetes in the U.S. Navy Atlantic Fleet Active Sonar Training (AFAST) Environmental Impact Statement (EIS) (U.S. Navy 2008). The values published in the AFAST EIS (A=10, K=45 dB SPL, and B = 120 dB SPL) were selected based on extensive research and coordination with NMFS.

Establishment of a risk modeling basement threshold (e.g. lowest noise level at which impacts could potentially occur) of 130 dB re 1 µPa was considered and eventually rejected. Average measured ambient noise levels in the portion of the Knik Arm due west of the JBER runway have been reported as being 119 dB re 1 µPa and 125 dB re 1 µPa (Blackwell and Greene 2002, KABATA *et al.* 2010). Sounds that are louder than ambient noise levels by less than the "critical ratio" and that are in the same frequency band as ambient noise sources, would not typically be perceived by the animal as a distinct noise source, and would not be expected to generate any direct behavioral reaction (Richardson *et al.* 1995). Odontocete critical ratios are typically between 10 and 20 dB at the lower frequencies concerned here, with the actual value varying by frequency and species (Richardson *et al.* 1995). Figure 1 shows F-22 noise energy in frequency bands between 10 and 10,000 Hz in several aircraft configurations, as taken from the NOISEFILE database. Jet noise is most intense in low frequency bands (e.g., <4000 Hz). Although jet noise does occur in frequency bands greater than 10 kHz it is of relatively low intensity and is not included in the NOISEFILE database. Ambient noise sources in the Knik Arm also have a majority of their noise energy at similarly low frequencies (Blackwell and Greene 2002). Therefore, aircraft overflight noise events less than 130 dB re 1 µPa (120 dB re 1 µPa ambient noise level plus 10 dB critical ratio) would be expected to be heard only indistinctly by belugas and would not be expected to generate any behavioral reaction. However, although unlikely, it is possible that belugas could perceive F-22 noise at levels below 130 dB re 1 µPa and have a behavioral reaction to the sound. To ensure conservative analysis results (i.e. over-estimation of potential effects), 120 dB re 1 μPa was adopted as the basement threshold for impacts.

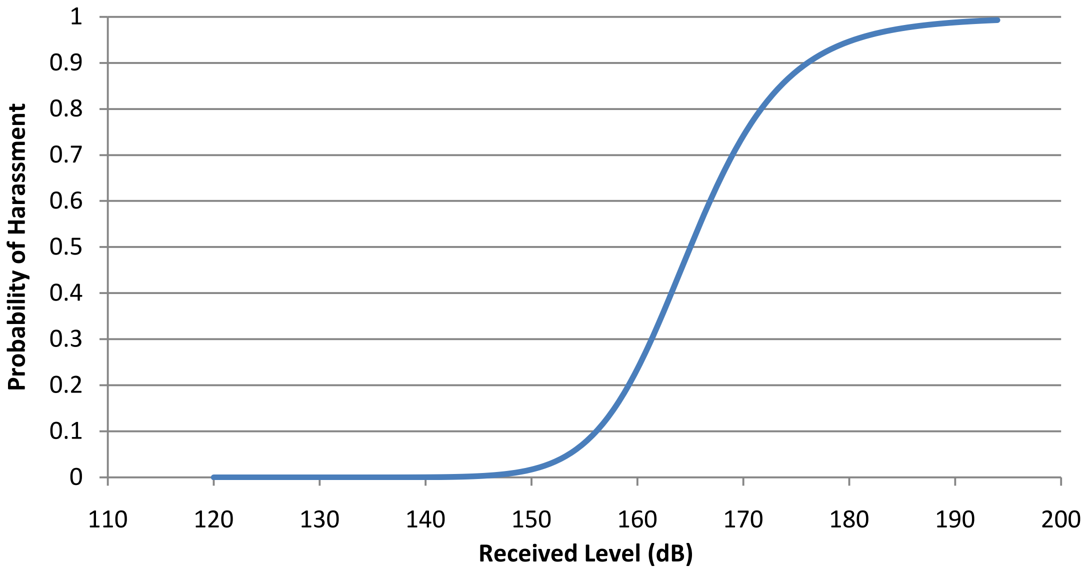


Figure 1. Risk Function Curve for Odontocetes

Source: U.S. Navy 2008

Step 4: Establish area exposed to noise exceeding thresholds. For each F-22 event type for which SPL exceeds 120 dB re 1 μPa at the loudest point, SEL_CALC was used to calculate the slant range at which noise level drops below 120, 125, and 130 dB re 1 μPa. Along each representative aircraft flight track, the aircraft altitude at several increments was calculated based on data reported by F-22 pilots. At each distance increment, the lateral distance from the flight track at which the critical slant range would be exceeded was calculated (see Figure 2). At a certain distance from the airfield, aircraft altitude is high enough that noise levels at the water's surface would not exceed 120 dB SPL re 1 μPa even directly beneath the flight track. Flight tracks and lateral distance to threshold noise level were plotted using ESRI Geographic Information System software and compared to shoreline to allow calculation of water area affected at 120-125 dB re 1 μPa, 125-130 dB re 1 μPa, and greater than 130 dB re 1 μPa.

According to Snell's Law, noise energy that intersects the water's surface at more than 13 degrees from vertical is almost entirely reflected. The area of maximum transmission can therefore be visualized as a 13-degree cone (26 degree aperture) with the aircraft at its apex. Outside of this area, only the upper few meters of the water column would typically be affected by elevated noise levels during an overflight. Because sound waves would have decreased to below threshold noise levels prior to reaching the bottom at any but the shallowest water depths, reflected sound energy from the bottom was not considered as part of this study.

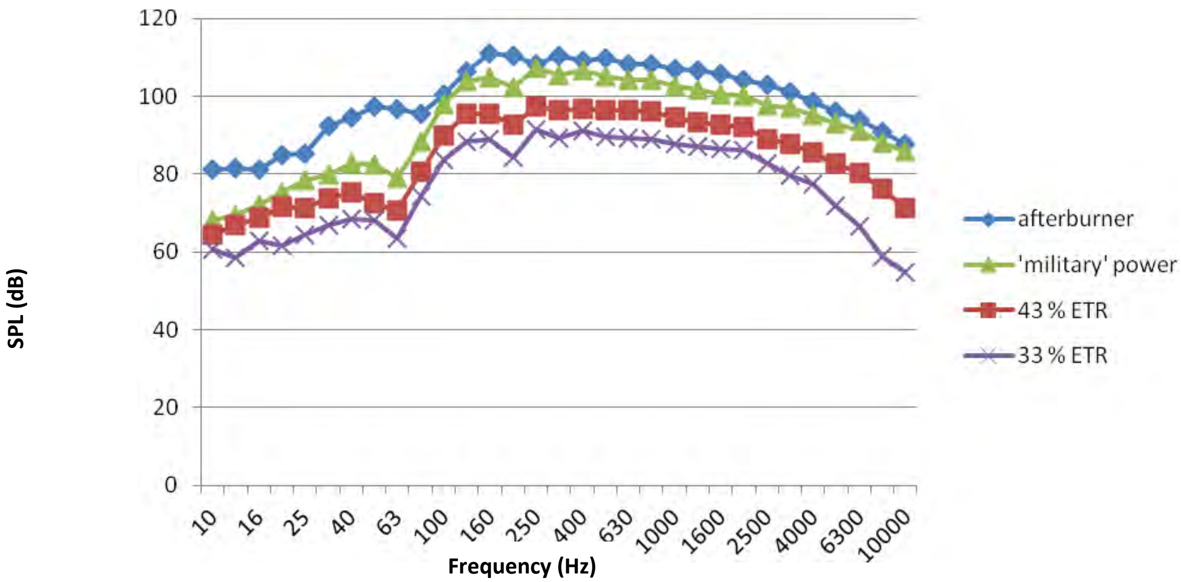


Figure 2. Un-weighted SPL re 20 µPa (In-Air) at 10-10,000 Hz Generated by F-22 Overflight at 1,000 AGL in Several Aircraft Configurations

When the sea surface is rough, a common condition in the Knik Arm, reflectance of noise energy is highly variable, depending on the angle at which incoming sound waves impact individual wave surfaces. In general, when the wave face is close to perpendicular to inbound sound rays, more energy enters the water. When sound rays happen to impact a wave face that is oblique to the direction of the ray, more energy is reflected from the water's surface. This variable transmission can lead to isolated volumes of water being very briefly exposed to higher noise levels than would occur under calm sea conditions. The location and extent of this phenomenon depends heavily on specific sea conditions. For simplicity, this analysis assumed equal transmission of sound waves across the air-water interface for anywhere the basement threshold of 120dB re 1 µPa is exceeded at the water's surface. Snell's law dictates sound wavesare only directly transmitted into the water at 13 degrees or less from the vertical. By ignoring Snell's law in the model, different sea states causing sound to enter the water in multiple transmission paths and evanescent surface scattering can be conservatively accounted for by calculating the largest possible footprint. It is also assumed for the analysis that the footprint extends from the surface to the bottom, even for areas outside of the 13-degree cone (26-degree aperture) dictated by Snell's law that would limit sound energy to the first few meters of the water column. Animals at depth would also experience lower sound levels than at the surface due to transmission loss in the water column.

Step 5: Determine the density of Cook Inlet beluga whales in Knik Arm. Surveys conducted as part of the Knik Arm Crossing Project, indicate that average beluga density during the month of September was 0.08 individuals per square kilometer (KABATA *et al.* 2010). September was the month during which the highest density of belugas was observed. However, to ensure conservative analysis results, a larger density value was used. The larger density value was based on the current (2010) estimated CIBW population of 340 individuals (NMFS 2010) divided by 2,800 km^2, the area estimated to represent 95 percent of the occupied CIBW range (Rugh et al. 2010), thus yielding a density estimate of 0.12 beluga whales/km^2.

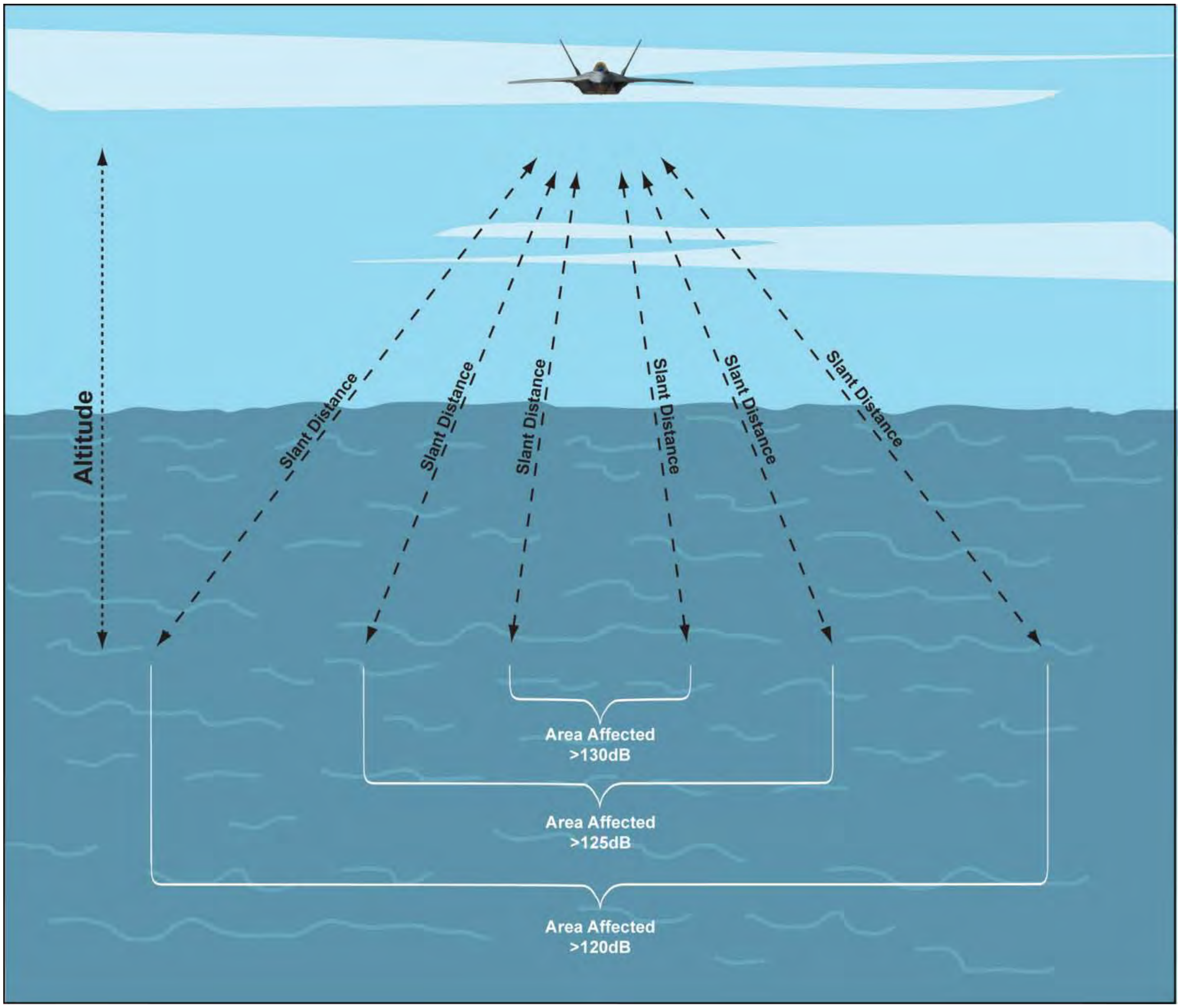


Figure 3. Calculation of Lateral Distance From Aircraft Flight Track At Which Surface Water Ensonified at >120, >125, and >130 dB SPL

Step 6: Calculate potential behavioral reactions. The number of times per average busy flying day (i.e., non-holiday weekday with reasonably good weather) that the proposed additional F-22 aircraft would conduct each event type was multiplied by the total number of average busy flying days per year.

The footprint bins (120-125dB; 125-130dB; and 130-137dB re 1 µPa) for each type of event (calculated above in step 4) were multiplied by the annual number of events to calculate total annual footprints per type of overflight. The number of animals exposed to levels in each footprint bin were then calculated by multiplying the highest Cook Inlet beluga whale density derived in any given month (see step 5 above) by the area of each of the annual footprints. Then, within each footprint bin, the number of animals that would likely exhibit a behavioral response was predicted by multiplying the number of animals exposed annually, by the probability of behavioral response at the highest sound level within that footprint bin according to the odontocete risk function (see step 3 above for an explanation of the odontocete risk function). To yield conservative impact estimates, the entire noise footprint area (i.e., 120-125 dB re 1 μPa, 125-130 dB re 1 μPa, and greater than 130 dB re 1 μPa) was treated as if it were affected by the highest noise level in that range. The probability corresponding to 125dB re 1 μPa was used for the 120-125 dB re 1 μPa footprint; 130dB re 1 μPa for 125-130 dB re 1 μPa; and 137dB re 1 μPa for the 130-137 dB re 1 μPa footprint. For each overflight type, the predicted behavioral reactions in each footprint bin are added to yield the predicted annual behavioral responses for that type of overflight. The number of animals predicted to exhibit a behavioral response annually for each type of event is then added together to yield the annual total number of predicted behavioral responses for all proposed F-22 overflight events.

1.17 Results

Based on application of the methodology described above, approximately 0.04 belugas would be behaviorally harassed annually resulting from proposed additional F-22 flying operations (Table 1).

Table 1. Estimated Annual Beluga Behavioral Responses Resulting From Proposed Additional F-22 Flying Operations

	Aircraft Configuration		*Noise Levels*		*Events Per Year*	*Number of Belugas in Affected Area*				*Risk of Behavioral Responses*			
	Lowest Altitude Over Water (MSL)	Power (% ETR)	LA_{max} Just Above Surface (dB re 20 µPa)	SPL Just Below Surface (dB re 1 µPa)	Additional Events Per Year (Proposed Action)	Area Affected at 120-125 dB SPL (sq km)	Area Affected at 125-130 dB SPL (sq km)	Area Affected at >130 dB SPL (sq km)	Approx. Beluga Density (Animals per km²)	Prob. of Behavioral Response at Highest Level Within 120-125 dB SPL	Prob. of Behavioral Response At Highest Level Within 125-130 dB SPL	Response at Highest Level >130 dB SPL (0 if max SPL <130)	Avg. # Additional Beluga Behavioral Responses Per Year (Proposed F-22 Ops)
EEEGL 2 Departure on RW 24 (military and A/B power departures identical at overwater segment)	2527	90	100.3	135.3	535	38.82	15.59	4.09	0.12	2.9E-10	2.9E-07	3.2E-05	8.8E-03
EEEGL 2 Departure on RW 34	4295	90	93.5	128.5	703	26.63	5.63	0.00	0.12	2.9E-10	1.0E-07	0.0E+00	4.9E-05
IFR Approach (IFR arrival and IFR closed pattern are idetical in overwater segment)	653	33	101.7	136.7	519	29.83	15.67	6.95	0.12	2.9E-10	2.9E-07	5.9E-05	2.6E-02
MATSU Transition (initial approach)	3500	33	82.3	117.3	593	0.00	0.00	0.00	0.12	0.0E+00	0.0E+00	0.0E+00	0.0E+00
RAPTR Transition (initial approach)	3706	43	88.1	123.1	446	5.05	0.00	0.00	0.12	1.7E-12	3.1E-11	0.0E+00	4.7E-10
ALL VFR approaches (overhead break) AND visual closed patterns	709	33	100.9	135.9	934	5.58	3.21	1.13	0.12	2.9E-10	2.9E-07	3.2E-05	4.2E-03
Re-entry Pattern (initial approach)	1700	33	91.3	126.3	24	13.84	5.47	0.00	0.12	2.9E-10	3.2E-08	0.0E+00	5.0E-07
TOTAL													**0.04**

1.18 Appendix 1 References

Blackwell, S. B. and C. R. Greene, Jr. 2002. Acoustic Measurements in Cook Inlet, Alaska, During August 2001. Prepared by Greeneridge Sciences for National Marine Fisheries Service, Protected Resources Division, Anchorage AK. 12 August.Department of the Navy (DoN). 2004. Report on the Results of the Inquiry into Allegations of Marine Mammal Impacts Surrounding the Use of Active Sonar by USS SHOUP (DDG 86) in the Haro Strait on or about 5 May 2003.

Feller, W. 1968. Introduction to Probability Theory and its Application. Vol. 1. 3rd ed John Wilay & Sons, NY, NY.

Finneran, J.J., and C.E. Schlundt. 2004. Effects of intense pure tones on the behavior of trained odontocetes. Space and Naval Warfare Systems Center, San Diego, Technical Document. September.

Finneran, J.J., D.A. Carder, and S.H. Ridgway. 2001. Temporary threshold shift (TTS) in bottlenose dolphins *Tursiops truncatus* exposed to tonal signals. Journal of the Acoustical Society of America. 1105:2749(A), 142nd Meeting of the Acoustical Society of America, Fort Lauderdale, FL. December.

_____. 2003. Temporary threshold shift measurements in bottlenose dolphins *Tursiops truncatus*, belugas *Delphinapterus leucas*, and California sea lions *Zalophus californianus*. Environmental Consequences of Underwater Sound (ECOUS) Symposium, San Antonio, TX, 12-16 May 2003.

Finneran, J.J., D.A. Carder, C.E. Schlundt and S.H. Ridgway. 2005. Temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*) exposed to mid-frequency tones. Journal of Acoustical Society of America. 118:2696-2705.

Fromm, D. 2004a. Acoustic Modeling Results of the Haro Strait For 5 May 2003. Naval Research Laboratory Report, Office of Naval Research, 30 January 2004.

_____. 2004b. EEEL Analysis of U.S.S. SHOUP Transmissions in the Haro Strait on 5 May 2003. Naval Research Laboratory briefing of 2 September 2004.

National Oceanic and Atmospheric Administration (NOAA). 2009. Taking and Importing Marine Mammals; U.S. Navy Training in the Hawaii Range Complex. NMFS, Final Rule, Federal Register 74, No. 7, 1465-1491, 12 January.

National Marine Fisheries Service (NMFS). 2005. Assessment of Acoustic Exposures on Marine Mammals in Conjunction with USS Shoup Active Sonar Transmissions in the Eastern Strait of Juan de Fuca and Haro Strait, Washington. 5 May 2003. National Marine Fisheries, Office of Protected Resources. Silver Spring, MD 20910.

_____. 2009. Endangered Species Act Section 7 Consultation, Biological Opinion, Proposed regulations to authorize the U.S. Navy to "take" marine mammals incidental to the conduct of training exercises in the Southern California Range Complex January 2009 to January 2014. NMFS, Silver Spring, MD, dated 14 Jan 2009, 293 pages.

_____. 2010. Biological Opinion, Endangered Species Act: Section 7 Consultation Biological Opinion. Knik Arm Crossing, Anchorage, Alaska. November 30, 2010. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Juneau, AK. 86 pp.

Nowacek, D.P., M.P. Johnson, and P.L. Tyack. 2004. North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting stimuli. Proceedings of the Royal Society of London, Part B 271:227-231.

KABATA (Knik Arm Bridge and Toll Authority) *et al*. 2010. Request for Letter of Authorization under Section 101(a)(5) of the Marine Mammal Protection Act Incidental to Construction of the Knik Arm Crossing Project in Upper Cook Inlet, Alaska. Submitted to Office of Protected Resources, National Marine Fisheries Service (NMFS), Silver Spring, MD 20910-3226 Submitted by: Knik Arm Bridge and Toll Authority, Anchorage, Alaska 99501; Alaska Department of Transportation and Public Facilities, Anchorage, Alaska 99501 and Federal Highway Administration, Juneau, Alaska 99802. Biological Consultant: HDR Alaska, Inc., Anchorage, Alaska. August 18.

Richardson, W.J., Greene, C.R., Malme, C.I., Thomson, D.H. 1995. Marine Mammals and Noise. Academic Press Inc.

Rugh, D.J., Shelden, K.W., Hobbs, R.C. 2010. Range Contraction in a Beluga Whale Population. Endangered Species Research. Vol 12: 69-75

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene, C.R., Kastak, D, Ketten, D.R., Miller, J.H., Natchigall, P.E., Rchardson, W.J., Thomas, J.A., Tyack, P.L. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals, Volume 33, Number 4. ISSN 0167-5427.

U.S. Navy. 2008. Atlantic Fleet Active Sonar Training Environmental Impact Statement/ Overseas Environmental Impact Statement. December 12.

APPENDIX 2. INFORMATION ON BELUGA WHALE HEARING AND VOCALIZATIONS*

*Provided by Keith Jenkins, SPAWARSYSCEN-PACIFIC, 71510 [keith.a.jenkins@navy.mil]

Beluga whale (*Delphinapterus leucas*) in-water vocalizations include whistles, squeals, bleats, yelps, bangs, chirps, trills, hums, peeps, yelps, blares, rasps, squawks, bangs, and growls, and clicks and creaks associated with echolocation (Fish and Mowbray, 1962; Anderson, 1974; Ford, 1975; Sjare, 1986; Thompson and Richardson, 1995). Beluga whales have also been reported to produce high pitched screams and a variety of squeaks and squeals above the water surface (Ford, 1975). Ford (1975) reported frequencies for beluga whale in-water social vocalizations to range 0.80–29 kHz with out-of-water vocalizations that ranged 0.95–20 kHz. Flat contour, upsweep, and variable contour sounds were recorded from a beluga whale calf that ranged in frequency from 400 Hz to 15.1 kHz (Parijs *et al*., 2003). Belikov and Bel'kovich (2007) identified 16 whistle types of beluga whales that had average values of maximum fundamental frequency between 1.4–4.5 kHz. Beluga whale echolocation vocalization frequencies have been reported to range 1.0–120 kHz (Ford, 1975, Au *et al*., 1985).

Measuring short-latent auditory evoked potentials (SAEP) of two male beluga whales with their heads above the water's surface, Popov and Supin (1987) reported their range of hearing to be limited to 110 kHz with a maximum sensitivity at 60–70 kHz. Using evoked potential methods, Klishin *et* al. (2000) also tested a captive beluga whale in a pool with its head out-of-water and reported a broader range of maximum sensitivities (32–108 kHz).

Results from behavioral tests conducted underwater in a concrete pool for two beluga whales indicated upper frequency limits around 122 kHz with maximum sensitivity around 30 kHz (White *et al*., 1978). Awbrey *et al*. (1988) measured the hearing sensitivity of a captive adult male, adult female and juvenile male beluga whale tested in a concrete pool using underwater behavioral techniques at test frequencies between 125 Hz and 8 kHz and reported an average threshold of 65 dB re 1 μPa at 8 kHz. The juvenile male was slightly more sensitive to low frequencies than either of the adults. Ridgway *et* al. (2001) reported behavioral hearing thresholds for two beluga whales at depths of 5, 100, 200 and 300 m in the open ocean at frequencies between 0.5 kHz to 100 kHz with maximum sensitivities between 8 and 24 kHz. In underwater behavioral tests conducted in San Diego Bay closer to the surface (i.e., 1.5 m), Finneran *et* al. (2002) reported that two captive beluga whales were able to detect 0.4 kHz tones at 117±1.6 dB re 1 μPa. Finneran *et al*. (2005) obtained underwater hearing thresholds for two other beluga whales housed and tested behaviorally in an indoor facility. Test frequencies that ranged 2.0–130 kHz. Best sensitivities for one subject ranged from approximately 40 to 50 dB re 1 μPa at 50–80 kHz with functional hearing above 100 kHz. The second subject had best sensitivity that ranged 40 to 50 dB re 1 μPa at 30–35 kHz and an upper frequency cutoff of about 50 kHz. The high-frequency hearing loss in the latter subject was attributed to the treatment with the aminoglycoside antibiotic amikacin which is toxic to hair cells in the cochlea of the ear.

Schlundt *et al.* (2000) reported temporary threshold shifts in the masked hearing thresholds (MTTS) of two beluga whales exposed to 1-s pure tones at 0.4, 3, 10, and 20 kHz. One of the subjects experienced a 12-dB MTTS in response to a 3-kHz tone of 195 dB re 1 μPa. The other subject experienced a 7-dB MTTS after exposure to a 10-kHz tone of 192 dB re 1 μPa. Both subjects had MTTSs of 6–12 dB following 20-kHz tones at levels between 197 to 201 dB re 1 μPa. Neither subject experienced an MTTS after exposure to 0.4 kHz tones up to 193 dB re 1 μPa. Deviations in the whales' trained behaviors were observed following exposures that ranged from 180-196 dB re 1 μPa at all four exposure frequencies.

Appendix 2 References

Anderson W.B. (1974) Acoustic signature of the beluga whale. Journal of the Acoustical Society of America 55.

Au W.W.L., Carder C.A., Penner R.H., Scronce B.L. 1985. Demonstration of adaptation in beluga whale echolocation signals. Journal of the Acoustical Society of America 77:726-730.

Awbrey F.T., Thomas J.A., Kastelein R.A. 1988. Low-frequency underwater hearing sensitivity in belugas, *Delphinapterus leucas*. Journal of the Acoustical Society of America 84:2273-2275.

Belikov R.A., Bel'kovich V.M. 2007. Whistles of beluga whales in the reproductive gathering off Solovetskii Island in the White Sea. Acoustical Physics 53:528–534.

Finneran J.J., Carder D.A., Ridgway S.H. 2002. Low-frequency acoustic pressure, velocity, and intensity thresholds in a bottlenose dolphin (*Tursiops truncatus*) and white whale (*Delphinapterus leucas*). Journal of the Acoustical Society of America 111:447-456.

Finneran J.J., Dear R., Carder D.A., Belting T., McBain J., Dalton L., Ridgway S.H. 2005. Pure tone audiograms and possible aminoglycoside-induced hearing loss in belugas (*Delphinapterus leucas*). Journal of the Acoustical Society of America 117:3936-3943.

Fish M.P., Mowbray W.H. 1962. Production of underwater sound by the White Whale or Beluga, *Delphinapterus leucas* (Pallus). Journal of Marine Research 20:149-161.

Ford J. 1975. Sound Production by the Beluga Whale, Delphinapterus leucas, in captivity.

Klishin V.O., Popov V.V., Supin A.Y. 2000. Hearing capabilities of a beluga whale, *Delphinapterus leucas*. Aquatic Mammals 26:212-228.

Popov V.V., Supin A.Y. 1987. Characteristics of hearing in the beluga *Delphinapterus leucas*. Doklady Akademii Nauk SSSR 294:1255-1258.

Ridgway S.H., Carder D.A., Kamolnick T., Smith R.R., Schlundt C.E., Elsberry W.R. 2001. Hearing and whistling in the deep sea: depth influences whistle spectra but does not attenuate hearing by white whales (*Delphinapterus leucas*) (Odontoceti, Cetacea). The Journal of Experimental Biology 204:3829-3841.

Schlundt C.E., Finneran J.J., Carder D.A., Ridgway S.H. 2000. Temporary shift in masked hearing thresholds of bottlenose dolphins, *Tursiops truncatus*, and white whales, *Delphinapterus leucas*, after exposure to intense tones. Journal of the Acoustical Society of America 107:3496-3508.

Sjare B.L., Smith T.G. 1986a. The vocal repertoire of white whales, *Delphinapterus leucas*, summering in Cunningham Inlet, Northwest Territories. Canadian Journal of Zoology 64:407-415.

______.1986b. The relationship between behavioral activity and underwater vocalizations of the white whale, *Delphinapterus leucus*. Canadian Journal of Zoology 64:2824-2831.

Thomson D.H., Richardson W.J. 1995. Marine mammal sounds, in: W. J. Richardson, et al. (Eds.), Marine Mammals and Noise, Academic Press, San Diego, CA. pp. 159-204.

Van Parijs S.M., Lydersen C., Kovacs K.M. 2003. Sounds produced by individual white whales, *Delphinapterus leucas*, from Svalbard during capture (L). Journal of the Acoustical Society of America 113:57-60.

White M.J., Norris J., Ljungblad D.K., Baron K., di Sciara G.N. 1978. Auditory thresholds of two beluga whales (*Delphinapterus leucas*), Hubbs Sea World Research Institute, San Diego.

This page intentionally left blank.

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673D AIR BASE WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

11-22-11

MEMORANDUM FOR NOAA Fisheries' National Marine Fisheries Service
Protected Resources Division and Habitat Conservation Divisions
Attn: Ms. Kate Savage

FROM: 673 CES/CC
6326 Arctic Warrior Drive
Joint Base Elmendorf-Richardson AK 99506-3240

SUBJECT: Wildlife Analysis for F-22 Supplemental Environmental Assessment

1. The United States Air Force (Air Force) is preparing an F-22 Plus-Up Environmental Assessment (EA) to evaluate the potential environmental consequences of the proposal to add six primary and one back-up F-22 aircraft to the Joint Base Elmendorf-Richardson (JBER) F-22 inventory, an increase in primary aircraft of approximately 17 percent. The purpose of the proposed plus-up is to provide additional Air Force capabilities at a strategic location to meet mission responsibilities for worldwide deployment. Additional F-22 aircraft are needed at JBER to provide U.S. Air Force capability to respond efficiently to national objectives, be available for contingencies, and enhance F-22 operational flexibility.

2. Pursuant to analysis of the proposed additional aircraft and to support compliance with the Endangered Species Act, we initiated an informal consultation in Oct 2010 and received information regarding federally listed threatened, endangered, candidate, and proposed to be listed species that occur or may occur in the potentially affected area from your office on 1 Nov 2010. Having reviewed the provided information, we are pleased to submit the attached Section 7 (Endangered Species Act) Compliance Wildlife Analysis for F-22 Plus-Up Environmental Assessment, Joint Base Elmendorf-Richardson (JBER) Alaska. A determination of "may affect not likely to adversely affect" is found for all species analyzed. We request your concurrence with the "the may affect not likely to adversely affect" determination with regard to species covered by your agency.

3. If you have any specific questions about the wildlife analysis or the proposal, please contact us. The primary point of contact is Ms. Ellen Godden, (907) 552-7483 and an alternate point of contact is Ms. Valerie Payne, (907) 552-3376. Thank you for your assistance in this matter.

J. DAVID NORTON, Lt Col USAF
Commander

Attachment:
Wildlife Analysis

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

February 22, 2011

Ms. Ellen Godden
673 CES/CEAOP
6326 Arctic Warrior Drive
Joint Base Elmendorf-Richardson, AK 99506-3240

Dear Ms. Godden:

The National Marine Fisheries Service (NMFS) has reviewed the "Section 7 (Endangered Species Act) Compliance Wildlife Analysis for F-22 Plus-Up Environmental Assessment" (EA), dated February 11, 2011. In your letter to NMFS, you requested concurrence that the proposed action "may affect, but is not likely to adversely affect", federally listed threatened, endangered or proposed species under NMFS' jurisdiction, including the Cook Inlet Beluga Whale and Western Distinct Population Segment (DPS) of Steller Sea Lion. An agency action is considered not likely to adversely affect listed species or designated critical habitat when its effects are expected to be completely beneficial, discountable, or insignificant. Beneficial effects are synchronous positive effects without any adverse effects to the species or critical habitat. Discountable effects are those extremely unlikely to occur. Insignificant effects relate to the size of the impact and may not reach the scale where take occurs. Based on best judgment, a person would not expect discountable effects to occur; or be able to meaningfully measure, detect or evaluate insignificant effects. The EA also considered project impacts on the five Primary Constituent Elements (PCE) of the proposed Cook Inlet beluga whale critical habitat (74 FR 63095, December 2, 2009) with the determination that the project would not result in adverse modification of the proposed critical habitat.

Summary of EA

The action concerns the addition of six primary and one backup F-22 aircraft to the existing fleet of 36 primary and three backup F-22 aircraft located at Joint Base Elmendorf-Richardson (JBER), Alaska. The increase of the six operational aircraft would increase the number of F-22 sorties by approximately 21 percent. The action area encompasses portions of the Knik Arm that are overflown by F-22 aircraft on established approach, departure and reentry patterns to the west and north of JBER runways. Two ESA listed species were included in the assessment, the Cook Inlet beluga whale and Steller sea lion.

Regarding Cook Inlet beluga whales (*Delphinapterus leucus*), both individuals and groups are seasonally common in Knik Arm adjacent to JBER. Whales have been noted milling, foraging and socializing in river mouths near Six Mile Creek, North Eagle Bay, Eagle River and Point McKenzie, primarily coincident with the coho salmon run. The greatest number of whales in Knik Arm has generally been observed between August and November, with the whales tending to move north into Knik Arm with the flooding tide, usually within one mile of the eastern shore, and move south out of Knik Arm on the ebbing tide, usually within one mile of the western shore. In or adjacent to JBER, whales have been observed in Eagle Bay and also occasionally feeding at the mouth of Six Mile Creek. Although up to 71 whales have been seen in Eagle Bay during a single summer observation, the average daily visits to the area included nine whales.

The EA then assessed impacts of the action on the Cook Inlet beluga whale, which include acoustic and visual disturbance. Because acoustic disturbance is the predominant impact of the action, the sound profile of the additional F-22's was evaluated in relation to the five major categories of acoustic effect, including 1. Direct trauma; 2. Auditory fatigue; 3. Auditory masking; 4. Stress response; and 5. Behavioral reactions. Neither direct trauma nor auditory fatigue was a predicted outcome of the action based on the level and duration of the modeled F-22 sound profile. The maximum sound pressure level of an F-22 overflight within water was calculated at 137 dB re 1 μPa for a duration of a few seconds, which was not considered sufficiently intense or long-lasting to result in direct trauma or auditory fatigue. Auditory masking was not expected because the F-22 overflight noise levels are close enough to ambient noise, which normally exceeds 120 dB re 1 μPa in the area, and are of very short duration. Regarding stress response and behavioral reactions, an analytical model was used to quantify potential behavioral disturbances based on predicted sound levels, animal threshold reactions to similar sounds and Cook Inlet beluga whale density. Based upon the results of all flight profiles, the number of behavioral reactions was conservatively estimated at less than 0.04 individuals per year. Additional factors for consideration included the possibility of habituation, the sound frequency of jet engines being predominantly lower than the best hearing range of belugas, the very brief duration of exposure and high ambient noise levels in the area. The likelihood of behavioral reaction was summarized as discountable. Potential visual impacts were considered minimal because of the flight altitude (weighted average of closest approach to water was 2,250 feet MSL for all flight paths), small size of the aircraft and rapidity of flight. Based on the acoustic and visual impact assessments, it was concluded that the project may affect, but is not likely to adversely affect the Cook Inlet beluga whale.

Project effects were also analyzed relative to the five Primary Constituent Elements of the proposed Cook Inlet beluga whale critical habitat. No effects were expected on water quality or hydrology, prey species or beluga whale passage within or between critical habitat, no introduction of toxins or harmful substances was expected and in water noise levels were not expected to result in the abandonment of habitat. It was concluded that the project would not result in adverse modification of the proposed critical habitat of the Cook Inlet beluga whale.

Regarding Steller sea lions (*Eumetopias jubatus*), the presence of the species is considered very rare in Knik Arm and the EA included the sighting of a single animal in 2009. With respect to potential impacts on Steller sea lions, the EA determined that, because the species does not normally occur in the action area, the combined likelihood of an occurrence and elevated F-22 noise event is discountable. Therefore, the action may affect, but is not likely to adversely affect the Western DPS of Steller sea lion.

Discussion

A. Cook Inlet Beluga Whale

The Cook Inlet beluga stock has probably always numbered fewer than several thousand animals, but has declined significantly from its historical abundance. In 1979, the Cook Inlet beluga stock was estimated at 1300 animals (Calkins 1989), which subsequently decreased to 653 animals in 1994 and to an estimated 340 in 2010 (NMFS 2010).

Beluga whales use sound rather than sight for many important functions, including communication, prey location and navigation. In Cook Inlet, beluga whales must compete acoustically with natural and anthropogenic sounds. Man-made sources of noise in Cook Inlet include large and small vessels, aircraft, oil and gas drilling, marine seismic surveys, pile driving, and dredging. The effects of man-made noise on beluga whales depend on several factors including the intensity, frequency and duration of the noise, the location and behavior of the whale, and the acoustic nature of the environment. High frequency noise diminishes more rapidly than lower frequency noises. Sound also dissipates more rapidly in shallow waters and over soft bottoms (sand and mud). Much of upper Cook Inlet is characterized by its shallow depth, sand/mud bottoms, and high background noise from currents and glacial silt (Blackwell and Greene 2002) thereby making it a poor acoustic environment.

Anthropogenic noise above ambient levels and within the same frequencies used by belugas may mask communication between these animals. At louder levels, noise may result in disturbance and harassment, or cause temporary or permanent damage to the whales' hearing. Although captive beluga whales have provided some insight into beluga hearing and the levels of noise that might damage their hearing capabilities, much less information is available on how noise might impact beluga whales behaviorally in the wild. In the Canadian high Arctic, beluga whales were observed to react to ice-breaking ships at distances of more than 80 km, showing strong avoidance, apparent alarm calls, and displacement (Finley et al. 1990). However, in less pristine, more heavily trafficked areas belugas may habituate to vessel noise.

Beluga whales have a well-developed sense of hearing and echolocation. These whales hear over a large range of frequencies, from about 40-75 Hertz (Hz) to 30-100 kiloHertz (kHz) (Richardson 1995), although their hearing is most acute at relatively high frequencies, between 10 and 100 kHz (Blackwell and Greene 2002), which is generally above the level of much industrial noise. The beluga whales' hearing falls off rapidly above 100 kHz. However, beluga whales may hear sounds as low as 40-75 Hz, although this noise would have to be very loud. Jet aircraft noise is most intense in relatively low frequency bands, primarily below 4 kHz.

Cook Inlet experiences significant levels of aircraft traffic. The Anchorage International Airport is directly adjacent to lower Knik Arm and has high volumes of commercial and cargo air traffic. Lake Hood and Spenard Lake in Anchorage are also heavily used by recreational seaplanes. Even though sound is attenuated by water surface, Blackwell and Green (2002) found that aircraft noise can be quite loud underwater when jet aircraft are directly overhead. Belugas may be less sensitive to aircraft noise than vessel noise, but individual responses may be highly variable and depend on the beluga's previous experiences, its activity at the time of the noise, and the characteristics of the noise. The area around lower Knik Arm, including the Port of Anchorage, is typically characterized by high levels of ambient noise. The EA cites levels as high as 143 re 1 μPa on shipping days for the Port of Anchorage and background levels rarely below 125 dB re 1 μPa. NMFS considers the Level A in-water harassment threshold to be 180 dB re 1 μPa for cetaceans. Level B harassment from pulsed noise is 160 dB re 1 μPa and 125 dB re 1 μPa from non-pulsed noise. Of the seven flight paths assessed, sound pressure levels (SPL) ranged from 117.3 to 137 dB re 1 μPa. The number of additional events at the maximum SPL was approximately 1.5 per day. Given the high ambient noise in the area, the low number of additional daily events which would be complete in a matter of seconds and the low probability of animals within the path of maximum SPL, the likelihood of behavioral change due to the additional F-22s is insignificant.

Beluga whales may also respond to visual disturbance. In the Beaufort Sea, belugas were observed diving or swimming away when low-flying (<500 m) aircraft passed directly over them (Richardson 1995). However, in Cook Inlet little or no change was noted in beluga swim direction with small aircraft flying at approximately 800 ft, which was considered most likely due to beluga habituation to routine, small aircraft overflights (Rugh et al. 2000). As the weighted closest approach of all F-22 flight paths is 2,250 feet, the likelihood of visual disturbance from the F-22 aircraft is insignificant.

With the exception of the in-water acoustic impacts as addressed above, the action does not include marine components and will, therefore, not affect the PCEs for proposed critical habitat. NMFS agrees that the project will not result in adverse modification of proposed critical habitat of the Cook Inlet beluga whale.

In summary, NMFS concurs with the determination that the proposed action may affect, but is not likely to adversely affect, the population of Cook Inlet beluga whales as well as the determination that the action will not cause adverse modification to proposed critical habitat.

B. Steller sea lions

The Western DPS of Steller sea lion inhabit much of Alaskan coastal waters west of 144°. Within this area, sea lions may traverse and forage over great distances, moving onto terrestrial haulout sites for rest, molting and predator avoidance and seasonal rookery sites for reproductive activities. Critical habitat for Steller sea lions has been designated based on the spatial extent of foraging, prey location and on the location of terrestrial haulout and rookery sites (NMFS 2008). Upper Cook Inlet, including Knik Arm, does not support any Steller sea lion rookeries, haulouts or critical habitat. The species is rarely found there, with the Forelands generally considered the most northerly limit of Steller sea lion range in Cook Inlet (M. Migura, personal communication, NMFS). NMFS agrees that the combined likelihood of Steller sea lion presence in the action area and F-22 overflight exposure is discountable and that the action may affect, but is not likely to adversely affect, the western DPS of Steller sea lion.

Conclusion

NMFS concurs with your agency's determination that the planned action may affect, but is not likely to adversely affect, ESA-listed species or designated critical habitat under NMFS jurisdiction, including Cook Inlet beluga whale and the western population of Steller sea lion. NMFS also concurs that the action will not result in adverse modification of proposed critical habitat for the Cook Inlet beluga whale.

Re-initiation of consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) take of a listed species occurs, (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not considered, (3) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered, or (4) a new species is listed or critical habitat designated that may be affected by the action. Should any questions or concerns arise, please contact Kate Savage at *Kate.Savage@noaa.gov.*

Sincerely,

James W. Balsiger, Ph.D.
Administrator, Alaska Region

Cc: Brad Smith

List of References

Blackwell, S.B. and C.R. Greene, Jr. 2002. Acoustic measurements in Cook Inlet, Alaska, during 2001. Report from Greeneridge Sciences, Inc., Aptos, CA, for NMFS, Anchorage, AK.

Calkins, D.G. 1989. Status of Belukha whales in Cook Inlet. In: Gulf of Alaska, Cook Inlet and North Aleutian Basin information update meeting. L. E. Jarvela and L. Thorsteinson (eds.). Anchorage, AK., Feb 7-8, 1989. Anchorage, AK.: USDOC, NOAA,OCSEAP, p 109-112.

Finley, K.J., G.W. Miller, R.A. Davis, and C.R. Greene. 1990. Reactions of belugas, *Delphinapterus leucas*, and narwhals, *Monodon monoceros*, to ice-breaking ships in the Canadian high Arctic. Canadian Bulletin of Fisheries and Aquatic Sciences 224: 97-117.

NMFS (National Marine Fisheries Service). 2010. Cook Inlet beluga population up since 2009; Overall trend still downward. NOAA Fisheries release, October 8, 2010. Accessed Oct. 12, 2010 at: http://www.fakr.noaa.gov/newsreleases/2010/belugapopulation.htm.

NMFS (National Marine Fisheries Service). 2008. Recovery Plan for the Steller Sea Lion, Eastern and Western Distinct Population Segments (*Eumetopias jubatus*), Revision. National Marine Fisheries Service, Juneau, Alaska. 325 pp.

Richardson, W. J., Greene, C. R., Jr., Koski, W. R., Malme, C. I., Miller, G. W., Smultea, M. A., et al. 1990.Acoustic effects of oil production activities on bowhead and white whales visible during spring migration near Pt. Barrow, Alaska—1989 phase (OCS Study MMS 90- 0017; NTIS PB91-105486). LGL Ltd. report for U.S. Minerals Management Service, Herndon, VA. 284 pp.

Rugh, D., Shelden, K. and B. Mahoney. 2000. Distribution of beluga whales in Cook Inlet, Alaska, during June/July 1993 to 1999. Mar. Fish. Rev. 62 (3): 6 -21.

This page intentionally left blank.

Appendix F

Review of Effects of Aircraft Noise, Chaff, and Flares on Biological Resources

This page intentionally left blank.

APPENDIX F REVIEW OF EFFECTS OF AIRCRAFT NOISE, CHAFF, AND FLARES ON BIOLOGICAL RESOURCES

F1 Introduction

This biological resources appendix addresses the effects of aircraft noise, including sonic booms, on wildlife and domestic animals. This appendix also considers the effects of training chaff and flares on biological resources under the training airspaces used by the Joint Base Elmendorf-Richardson (JBER) F-22s and the transient F-15Cs.

F2 Aircraft Noise

The review of the noise effects literature shows that the most documented reaction of animals newly or infrequently exposed to low-altitude aircraft and sonic booms is the "startle effect." Although an observer's interpretation of the startle effect is behavioral (e.g., the animal runs in response to the sound or flinches and remains in place), it does have a physiological basis. The startle effect is a reflex; it is an autonomic reaction to loud, sudden noise (Westman and Walters 1981, Harrington and Veitch 1991). Increased heart rate and muscle flexion are the typical physiological responses.

The literature indicates that the type of noise that can stimulate the startle reflex is highly variable among animal species (Manci et al. 1988). In general, studies have indicated that close, loud, and sudden noises that are combined with a visual stimulus produce the most intense reactions. Rotary wing aircraft (helicopters) generally induce the startle effect more frequently than fixed wing aircraft (Gladwin et al. 1988, Ward et al. 1999). Similarly the "crack-crack" of a nearby sonic boom has a higher potential to startle an animal compared to the thunder-like sound from a distant sonic boom. External physical variables, such as landscape structure and wind, can also lessen the animal's perception of and response to aircraft noise (Ward et al. 1999).

Animals can habituate to fixed wing aircraft noise as demonstrated under controlled conditions (e.g., Conomy *et al.* 1998, Krausman *et al.* 1998) and by observations reported by biologists working in parks and wildlife refuges (Gladwin *et al.* 1988). Brown *et al.* (1999) defined habituation as "… an active learning process that permits individuals to discard a response to a recurring stimulus for which constant response is biologically inappropriate without impairment of their ability to respond to other stimuli." However, species can differ in their ability to habituate to aircraft noise, particularly the sporadic noise associated with military aircraft training (e.g., Conomy *et al.* 1998). Furthermore, there are no studies that have investigated the potential for adverse effects to wildlife due to long-term exposure to aircraft noise.

F2.1 Ungulates

Wild ungulates appear to vary in sensitivity to aircraft noise. Responses reported in the literature varied from no effect and habituation to panic reactions followed by stampeding (Weisenberger *et al.* 1996; see reviews in Manci *et al.* 1988). Aircraft noise has the potential to be most detrimental during periods of stress, especially winter, gestation, and calving (DeForge 1981). Krausman *et al.* (1998) studied the response of wild bighorn sheep (*Ovis canadensis*) in a 790-acre enclosure to frequent F-16 overflight at 395 feet AGL. Heart rate increased above preflight level during 7 percent of the overflights but returned to normal within 120 seconds. No behavioral response by the bighorn sheep was observed during the overflights.

Wild ungulates typically have little to no response to sonic booms. Workman *et al.* (1992) studied the physiological and behavioral responses of pronghorn (*Antilocapra americana*), elk (*Cervus elaphus*), and bighorn sheep to sonic booms. All three species exhibited an increase in heart rate lasting from 30 seconds to 1 ½ minutes in response to their first exposure to a sonic boom. After successive sonic booms, this response decreased greatly, indicating habituation.

A recent study in Alaska documented only mild short-term reactions of caribou (*Rangifer tarandus*) to military overflights in the Yukon Military Operations Areas (MOAs) (Lawler *et al.* 2005). A large portion of the Fortymile Caribou Herd calves underneath the Yukon MOAs. The authors concluded that military overflights did not cause any calf deaths, nor did cow-calf pairs exhibit increased movement in response to the overflights. Because daily movements increase with calf age, the authors controlled for calf age in their analysis. Lawler *et al.* (2005) generally only observed higher-level reactions, such as rising quickly from a bedded position or extended running, when the faster F-15 and F-16s were within 1,000 feet above ground level (AGL). They also noted considerable variation in responses due to speed, slant distance, group size and activity, and even individual variation with groups.

In contrast, a study of the Delta Caribou Herd in interior Alaska found that female caribou with calves exposed to low-altitude overflights moved about 2.5 kilometers more per day than those not exposed (Maier *et al.* 1998). The authors, however, stated that this distance was of low energetic cost. Furthermore, this study did not consider calf age in their analyses (Lawler *et al.* 2005), which may bias results. Harrington and Veitch (1991) expressed concern for survival and health of woodland caribou calves in Labrador, where military training flights are allowed within 100 feet AGL.

Few studies of the effects of low-altitude overflights have been conducted on moose (*Alces alces*) or Dall's sheep (*Ovis dalli*). Andersen *et al.* (1996) observed that moose responded more adversely to human stimuli than mechanical stimuli. Beckstead (2004) reported on a study of the effects of military jet overflights on Dall's sheep under the Yukon 1 and 2 MOAs in Alaska. He could find no difference in population trends, productivity, survival rates, behavior, or habitat use between areas mitigated and not mitigated for low-level military aircraft by the Alaska MOAs Environmental Impact Statement (EIS) (United States Air Force [Air Force] 1995). In the mitigated area, flights are restricted to above 5,000 feet AGL during the lambing season, while the unmitigated area could experience flights as low as 100 feet AGL. Similarly, large-force Major Flying Exercises did not adversely affect Dall's sheep.

F2.2 Marine Mammals

The effects of noise on marine mammals, such as dolphins and whales, have been relatively well studied. A detailed analysis of noise properties in water and the potential effects on marine mammals are presented in Append E.

F2.2 Small Mammals

A few researchers have studied the potential affects of aircraft noise on small mammals. Chesser *et al.* (1975) found that house mice (*Mus musculus*) trapped near an airport runway had larger adrenal glands than those trapped 2 kilometers from the airport. In the lab, naïve mice subjected to simulated aircraft noise also developed larger adrenal glands than a control group. However, the implications of enlarged adrenals for small mammals with a relatively short life span are undetermined. The burrows of some small mammals may reduce their exposure to aircraft noise. Francine *et al.* (1995) found that kit foxes (*Vulpes macrotis*) with twisting tunnels leading to deeper burrows experienced less noise than kangaroo rats (*Dipodomys merriami*) with shallow burrows. McClenaghan and Bowles (1995) studied the effects of aircraft overflights on small mammals and were unable to distinguish potential long-term effects due to aircraft noise compared to other environmental factors.

F2.2 Raptors

Most studies have found few negative effects of aircraft noise on raptors. Ellis *et al.* (1991) examined behavioral and reproductive responses of several raptor species to low-level flights. No incidents of reproductive failure were observed and site re-occupancy rates were high (95 percent) the following year. Several researchers found that ground-based activities, such as operating chainsaws or an intruding human, were more disturbing than aircraft (White and Thurow 1985, Grubb and King 1991, Delaney *et al.* 1997). Red-tailed hawks (*Buteo jamaicensis*) and osprey (*Pandion haliaetus*) appeared to readily habituate to regular aircraft overflights (Andersen *et al.* 1989, Trimper *et al.* 1998). Mexican spotted owls (*Strix occidentalis lucida*) did not flush from a nest or perch unless a helicopter was as close as 330 feet (Delaney *et al.* 1997). Nest attendance, time-activity budgets, and provisioning rates of nesting peregrine falcons (*Falco peregrinus*) in Alaska were found not to be significantly affected by jet aircraft overflights (Palmer *et al.* 2003). On the other hand, Andersen *et al.* (1990) observed a shift in home ranges of four raptor species away from new military helicopter activity, which supports other reports that wild species are more sensitive to rotary wing aircraft than fixed-wing aircraft.

The effects of aircraft noise on the bald eagle (*Haliaetus leucocephalus*) have been studied relatively well, compared to most wildlife species. Overall, there have been no reports of reduced reproductive success or physiological risks to bald eagles exposed to aircraft overflights or other types of military noise (Fraser *et al.* 1985, Stalmaster and Kaiser 1997, Brown *et al.* 1999; see review in Buehler 2000). Most researchers have documented that pedestrians and helicopters were more disturbing to bald eagles than fixed-wing aircraft, including military jets (Fraser *et al.* 1985, Grubb and King 1991, Grubb and Bowerman 1997). However, bald eagles can be disturbed by fixed-wing aircraft. Recorded reactions to disturbance ranged from an alert posture to flushing from a nest or perch. Grubb and King (1991) reported that 19 percent of breeding eagles were disturbed when an aircraft was within 625 meters (2,050 feet).

F2.2 Waterfowl and Other Waterbirds

In their review, Manci *et al.* (1988) noted that aircraft can be particularly disturbing to waterfowl. Conomy *et al.* (1998) suggested, though, that responses were species-specific. They found that black ducks (*Anas rubripes*) were able to habituate to aircraft noise, while wood ducks (*Aix sponsa*) did not. Black ducks exhibited a significant decrease in startle response to actual and simulated jet aircraft noise over a 17-day period, but wood duck response did not decrease uniformly following initial exposure. Some bird species appear to be more sensitive to aircraft noise at different times of the year. Snow geese (*Chen caerulescens*) were more easily disturbed by aircraft prior to fall migration than at the beginning of the nesting season (Belanger and Bedard 1989). On an autumn staging ground in Alaska (i.e., prior to fall migration), 75 percent of brant (*Branta bernicla*) and only 9 percent of Canada geese (*Branta canadensis*) flew in response to aircraft overflights (Ward *et al.* 1999). There tended to be a greater response to aircraft at 1,000 to 2,500 feet AGL than at lower or higher altitudes. In contrast, Kushlan (1979) did not observe any negative effects to wading bird colonies (i.e., rookeries) when fixed-wing aircraft conducted surveys within 200 feet AGL; 90 percent of the observations indicated no reactions from the birds. Nesting California least terns (*Sterna albifrons browni*) did not respond negatively to a nearby missile launch (Henningson, Durham, and Richardson 1981).

Previous research also shows varied responses of waterbirds to sonic booms. Burger (1981) found that herring gulls (*Larus argentatus*) responded intensively to sonic booms and many eggs were broken as adults flushed from nests. One study discussed by Manci *et al.* (1988) described the reproductive failure of a colony of sooty terns (*Sterna fuscata*) on the Dry Tortugas reportedly due to sonic booms. However, based on laboratory and numerical models, Ting *et al.* (2002) concluded that sonic boom overpressures from military operations of existing aircraft are unlikely to damage avian eggs.

F2.2 Domestic Animals

As with wildlife, the startle reflex is the most commonly documented effect on domestic animals. Results of the startle reflex are typically minor (e.g., increase in heart rate or nervousness) and do not result in injury. Espmark *et al.* (1974) did not observe any adverse effects due to minor behavioral reactions to low-altitude flights with noise levels of 95 to 101 A-weighted decibels (dBA). They noted only minimal reactions of cattle and sheep to sonic booms, such as muscle and tail twitching and walking or running short distances (up to 65 feet). More severe reactions may occur when animals are crowded in small enclosures, where loud, sudden noise may cause a widespread panic reaction (Air Force 1993). Such negative impacts were typically only observed when aircraft were less than 330 feet AGL (United States Forest Service 1992). Several studies have found little direct evidence of decreased milk production, weight loss, or lower reproductive success in response to aircraft noise or sonic booms. For example, Head *et al.* (1993) did not find any reductions in milk yields with aircraft Sound Exposure Levels (SEL) levels of 105 to 112 dBA. Many studies documented that domestic animals habituate to aircraft noise (see reviews in Manci *et al.* 1998; Head *et al.* 1993).

There is little direct evidence that aircraft noise or sonic booms can cause domestic chicken eggs to crack or result in lower hatching rates. Stadelman (1958) did not observe a decrease in hatchability when domestic chicken eggs were exposed to loud noises measured at 96 dB inside incubators and 120 dB outside. Bowles and Seddon (1994) found no difference in the hatch rate of four groups of chicken eggs exposed to 1) no sonic booms (control group), 2) sonic booms of 3 pounds per square foot (psf), 3) sonic booms of 20 psf, and 4) sonic booms of 30 psf. No eggs were cracked by the sonic booms and all chicks hatched were normal.

F3 Training Chaff and Flares

Specific issues and potential impacts of training chaff and flares on biological resources are discussed below. These issues have been identified by Department of Defense (DoD) research (Air Force 1997, Cook 2001), General Accounting Office review (United States General Accounting Office 1998), independent review (Spargo 1999), resource agency instruction, and public concern and perception. No reports to date have documented negative impacts of training chaff and flares to biological resources. These studies are reviewed below.

Concerns for biological resources are related to the residual materials of training chaff and flares that fall to the ground or dud flares. Residual materials are several flare components, including plastic end caps, felt spacers, aluminum-coated wrapping material, plastic retaining devices, and plastic pistons. Specific issues are (1) ingestion of chaff fibers or flare residual materials; (2) inhalation of chaff fibers; (3) physical external effects from chaff fibers, such as skin irritation; (4) effects on water quality and forage quality; (5) increased fire potential; and (6) potential for being struck by large flare debris (the plastic Safe and Initiation [S&I] device of the MJU-7 A/B flare).

Because of the low rate of application and dispersal of training chaff fibers and flare residues during defensive training, wildlife and domestic animals would have little opportunity to ingest, inhale, or otherwise come in contact with these residual materials. Although some chemical components of chaff are toxic at high levels, such levels could only be reached through the ingestion of many chaff bundles or billions of chaff fibers. Barrett and MacKay (1972) documented that cattle avoided consuming clumps of chaff in their feed. When calves were fed chaff thoroughly mixed with molasses in their feed, no adverse physiological effects were observed pre- or post-mortem.

Chaff fibers are too large for inhalation, although chaff particles can degrade to small pieces. However, the number of degraded or fragmented particles is insufficient to result in disease (Spargo 1999). Chaff is similar in form and softness to very fine human hair, and is unlikely to cause negative reactions if animals were to inadvertently come in contact with it.

Chaff fibers could accumulate on the ground or in water bodies. Studies have shown that chaff breaks down quickly in humid environments and acidic soil conditions (Air Force 1997). In water, only under very high or low pH could the aluminum in chaff become soluble and toxic (Air Force 1997). Few organisms would be present in water bodies with such extreme pH levels. Given the small amount of diffuse or aggregate chaff material that could possibly reach water bodies, water chemistry would not be expected to be affected. Similarly, the magnesium in flares can be toxic at extremely high levels, a situation that could occur only under repeated and concentrated use in localized areas. Flare ash would disperse over wide areas; thus, no impact is expected from the magnesium in flare ash. The probability of an intact dud flare leaving an aircraft during training and falling to the ground outside of a military base is estimated to be 0.01 percent (Air Force 2001). Since toxic levels would require several dud flares to fall in one confined water body, no effect of flares on water quality would be expected. Furthermore, uptake by plants would not be expected to occur.

The expected frequency of an S&I device from an MJU-7 A/B or MJU-10/B flare striking an exposed animal depends on the number of flares used and the size and population density of the exposed animals. Calculations of potential strikes to a human-sized animal with a density of 50 animals per square mile, where 8,000 flares were used annually, was one strike in 200 years. An animal 1/100th the size of a human with a density of 500 animals per square mile exposed 100 percent of the time (i.e., animals not protected by burrows or dense vegetation) would also have an expected strike rate of one in 200 years. The S&I device strikes with the force of a medium-sized hailstone. Such a strike to a bird, small mammal, or reptile could produce a mortality. The very small likelihood of such a strike, especially when compared with more immediate threats such as highways, would not be expected to have any effect on populations of small species. Strikes to larger species, such as wild ungulates or farm animals could produce a bruise and a startle reaction. Such a strike from an S&I device would not be expected to seriously injure or otherwise significantly affect natural or domestic species.

Flare debris also includes aluminum-coated mylar wrapping and lighter plastic parts. The plastic parts, such as end caps, are inert and are not expected to be used by or consumed by any species. The aluminum coated wrapping, as it degrades, could produce fibrous materials similar to naturally occurring nesting materials. There is no known case of such materials being used in nest construction. In a study of pack rats (*Neotoma* spp.), a notorious collector of odd materials, no chaff or flare materials were found in nests on military ranges subject to decades of dispensing chaff and flares (Air Force 1997). Although lighter flare debris could be used by species under the airspace, such use would be expected to be infrequent and incidental.

Bovine hardware disease is of concern for domestic cattle. Hardware disease, or traumatic reticuloperitonitis, is a relatively common disease in cattle. The disease results when a cow ingests a foreign object, typically metallic. The object can become lodged in the wall of the stomach and can penetrate into the diaphragm and heart, resulting in pain and infection; in severe cases animals can die without treatment. Treatment consists of antibiotics and/or surgery. Statistics are not readily available, but one study documented that 55-75 percent of cattle slaughtered in the eastern United States (U.S.) had metallic objects in their stomachs, but the objects did not result in damage (Moseley 2003). Dairy cattle are typically more vulnerable to hardware disease due to the confined nature of diary operations. Many livestock managers rely on magnets inserted into the cow's stomach to prevent and treat hardware disease. The magnet attracts metallic objects, thereby preventing them from traveling to the stomach wall.

The culprit of bovine hardware disease is often a nail or piece of wire greater than 1 inch in length, such as that used to bale hay (Cavedo et al. 2004). If livestock ingested residual materials of the M-206, MJU-7 A/B, and MJU-10/B flares, the plastic materials of the end cap and slider and the flexible aluminum wrapping would be less likely to result in injury than a metallic object.

Flares used for training by F-22 and F-15 aircraft are designed to burn out within approximately 400 feet of the release altitude. Given the minimum allowable release altitudes for flares, this leaves an extensive safety margin to prevent any burning materials from reaching the ground (Air Force 2001). In the Alaska training airspace, flares must be released above 5,000 feet AGL from June 1 to September 30 to reduce any potential of a flare-caused fire. For the remainder of the year when soils and vegetation are moist or snow covered, flares can be released above 2,000 feet AGL. Plastic and aluminum coated wrapping materials from flares that do reach the ground would be inert. The percentage of flares that malfunction is small (<1 percent probability for all categories of malfunction; Air Force 2001). Dud flares (i.e., those that do not ignite at release and fall intact to the ground) contain magnesium, which is thermally stable and requires a temperature of 1,200 degrees Fahrenheit for ignition. Self-ignition is highly unlikely under natural conditions.

F4 References

Andersen, D.E., O.J. Rongstad, and W.R. Mytton. 1989. Response of Nesting Red-tailed Hawks to Helicopter Overflights. Condor 91:296-299.

_____ . 1990. Home-Range Changes in Raptors Exposed to Increased Human Activity Levels in Southeastern Colorado. Wildlife Society Bulletin 18(2):134-142.

Andersen, R., J.D.C. Linnell, and R. Langvatn. 1996. Short Term Behavioral and Physiological Responses of Moose *Alces alces* to Military Disturbance in Norway. Biological Conservation 77:169-176.

Barrett, B.B., and R.R. MacKay. 1972. The Ingestion of Fiberglass Chaff by Cattle. Animal Diseases Research Institute, Canada Department of Agriculture/Health of Animals Branch.

Beckstead, D. 2004. The Effects of Military Jet Overflights on Dall's Sheep in Interior Alaska. Available at http://www.nps.gov/yuch/Expanded/key_resources/sheep/2004_sheep_report/toc.htm. Accessed December 29, 2005.

Belanger, L. and J. Bedard. 1989. Responses of Staging Greater Snow Geese to Human Disturbance. Journal of Wildlife Management 53(3):713-719.

Bowles, A. E., and M. D. Seddon. 1994. Effects of simulated sonic booms on the hatchability of white leghorn chicken eggs. Armstrong Laboratory, Air Force Materiel Command, Brooks Air Force Base, TX. AL/OE-TR-0179.

Brown, B.T., G.S. Mills, C. Powels, W.A. Russell, G.D. Therres, and J.J. Pottie. 1999. The Influence of Weapons-Testing Noise on Bald Eagle Behavior. Journal of Raptor Research 33(3):227-232.

Buehler, D.A. 2000. Bald Eagle (*Haliaeetus leucocephalus*). In The Birds of North America, No. 506 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Burger, J. 1981. Behavioral Responses of Herring Gulls *Larus argentatus* to Aircraft Noise. Environmental Pollution (Series A):177-184.

Cavedo, A. M., K. S. Latimer, H. L. Tarpley, and P. J. Bain. 2004. Traumatic Reticulopertonitis (Hardware Disease) in Cattle. Class of 2004 and Department of Pathology, College of Veterinary Medicine, University of Georgia, Athens, GA. Available at http://www.vet.uga.edu/vpp/clerk/cavedo. Accessed 6/23/2005.

Chesser, R.K., R.S. Caldwell, and M.J. Harvey. 1975. Effects of Noise on Feral Populations of *Mus musculus*. Physiological Zoology 48(4):323-325.

Conomy, J.T., J.A. Dubovsky, J.A. Collazo, and W.J. Fleming. 1998. Do Black Ducks and Wood Ducks Habituate to Aircraft Disturbance? Journal of Wildlife Management 62(3):1135-1142.

Cook, B.C. 2001. Investigation of Abrasion, Fragmentation and Re-suspension of Chaff. Master's Thesis. Christopher Newport University.

DeForge, J.R. 1981. Stress: Changing Environments and the Effects on Desert Bighorn Sheep. Desert Bighorn Council 1981 Transactions.

Delaney, D.K., T.G. Grubb, and L.L. Pater. 1997. Effects of Helicopter Noise on Nesting Mexican Spotted Owls. Project Order No. DE P.O. 95-4, U.S. Air Force, Holloman Air Force Base, New Mexico.

Ellis, D.H., C.H. Ellis, and D.P. Mindell. 1991. Raptor Responses to Low-Level Jet Aircraft and Sonic Booms. Environmental Pollution 74:53-83.

Erbe, C., and D. M. Farmer. 2000. Zones of Impact around Icebreakers Affecting Beluga Whales in the Beaufort Sea. Journal of the Acoustical Society of America 108(3):1332-1340.

Espmark, Y., L. Falt, and B. Falt. 1974. Behavioral Responses in Cattle and Sheep Exposed to Sonic Booms and Low-altitude Subsonic Flight Noise. The Veterinary Record 94:106-113.

Francine, J.K., J.S. Yaeger, and A.E. Bowles. 1995. Sound from Low-Altitude Jet Overflights in Burrows of the Merriam's Kangaroo Rat, *Dipodomys merriami*, and the Kit Fox, *Vulpes macrotis*. *In* R. J. Bernhard and J. S. Bolton. Proceedings of Inter-Noise 95: The 1995 International Congress on Noise Control Engineering. Volume II. Pages 991-994.

Fraser, J.D., L.D. Frenzel, and J.E. Mathisen. 1985. The Impact of Human Activity on Breeding Bald Eagles in North-Central Minnesota. Journal of Wildlife Management 49(3):585-592.

Gladwin, D.N., D.A. Asherin, and K.M. Manci. 1988. Effects of Aircraft Noise and Sonic Booms on Fish and Wildlife. Results of a Survey of U.S. Fish and Wildlife Service Endangered Species and Ecological Services Field Offices, Refuges, Hatcheries, and Research Centers. U.S. Fish and Wildlife Service, National Ecology Research Center, Fort Collins, Colorado.

Grubb, T.G. and R.M. King. 1991. Assessing Human Disturbance of Breeding Bald Eagles with Classification Tree Models. Journal of Wildlife Management 55(3):500-511.

Grubb, T.G. and W.W. Bowerman. 1997. Variations in Breeding Bald Eagle Responses to Jets, Light Planes and Helicopters. Journal of Raptor Research 31(3):213-222.

Harrington, F.H., and A.M. Veitch. 1991. Short-term Impacts of Low-level Jet Fighter Training on Caribou in Labrador. Arctic 44(4):318-327.

Head, H. H., R. C. Kull, Jr., M. S. Campos, K. C. Bachman, C. J. Wilcox, L. L. Cline, and M. J. Hayen. 1993. Milk Yield, Milk Composition, and Behavior of Holstein Cows in Response to Jet Aircraft Noise before Milking. Journal of Dairy Science 76:1558-1567.

Henningson, Durham and Richardson. 1981. Effects of Minuteman Launch on California Least Tern Nesting Activity, Vandenberg AFB, California. Prepared for U.S. Air Force, Ballistic Missile Office, Norton Air Force Base, California.

Krausman, P.R., M.C. Wallace, K.L. Hayes, and D.W. DeYoung. 1998. Effects of Jet Aircraft on Mountain Sheep. Journal of Wildlife Management 62(4):1246-1254.

Kushlan, J. A. 1979. Effects of Helicopter Censuses on Wading Bird Colonies. Journal of Wildlife Management 43(3):756-760.

Lawler, J. P., A. J. Magoun, C. T. Seaton, C. L. Gardner, R. D. Bobertje, J. M. Ver Hoef, and P. A. Del Vecchio. 2005. Short-term Impacts of Military Overflights on Caribou during Calving Season. Journal of Wildlife Management 69(3):1133-1146.

Maier, J. A. K., S. M. Murphy, R. G. White, and M. D. Smith. 1998. Responses of Caribou to Overflights by Low-Altitude Jet Aircraft. Journal of Wildlife Management 62(2):752-766.

Manci, K.M., D.N. Gladwin, R. Villella, and M. Cavendish. 1988. Effects of Aircraft Noise and Sonic Booms on Domestic Animals and Wildlife: a Literature Synthesis. U.S. Fish and Wildlife Service National Ecology Research Center, Ft. Collins, CO. NERC-88/29.

McClenaghan, L, and A.E. Bowles. 1995. Effects of Low-Altitude Overflights on Populations of Small Mammals on the Barry M. Goldwater Range. *In* R. J. Bernhard and J. S. Bolton. Proceedings of Inter-Noise 95: The 1995 International Congress on Noise Control Engineering. Volume II. Pages 985-990.

Moore, S. E., and J. T. Clarke. 2002. Potential Impact of Offshore Human Activities on Gray Whales (*Eschrichtius robustus*). Journal of Cetacean Research and Management 4(1):19-25.

Moseley, B. L. 2003. Hardware Disease in Cattle. University of Missouri, MU Extension. Available at http://muextension.missouri.edu/explore/agguides/pests/g07700.htm. Accessed 7/26/2005.

Palmer, A.G., D.L. Nordmeyer, and D.D. Roby. 2003. Effects of Jet Aircraft Overflights on Parental Care of Peregrine Falcons. Wildlife Society Bulletin 31(2):499-509.

Perry, E. A., D. J. Boness, and S. J. Insley. 2002. Effects of Sonic Booms on Breeding Gray Seals and Harbor Seals on Sable Island, Canada. Journal of the Acoustical Society of America 111(1):599-609.

Spargo, B.J. 1999. Environmental Effects of RF Chaff: a Select Panel Report to the Undersecretary of Defense for Environmental Security. NRL/PU/6100—99-389, Washington, D.C.

Stadelman, W.J. 1958. The effect of sounds of varying intensity on hatchability of chicken eggs. Poultry Sciences 37:166-169.

Stalmaster, M.V. and J.L. Kaiser. 1997. Flushing Responses of Wintering Bald Eagles to Military Activity. Journal of Wildlife Management 61(4):1307-1313.

Stocker, M. 2002. Fish, Mollusks and other Sea Animals, and the Impact of Anthropogenic Noise in the Marine Acoustical Environment. Michael Stocker Associates, For Earth Island Institute.

Ting, C., J. Garrelick, and A. Bowles. 2002. An Analysis of the Response of Sooty Tern Eggs to Sonic Boom Overpressures. The Journal of the Acoustical Society of America 111(1):562-568.

Trimper, P.G., N.M. Standen, L.M. Lye, D. Lemon, T.E. Chubbs, and G.W. Humphries. 1998. Effects of Low-level Jet Aircraft Noise on the Behaviour of Nesting Osprey. Journal of Applied Ecology 35:122-130.

United States Air Force (Air Force). 1993. The Impact of Low Altitude Flights on Livestock and Poultry. AF Handbook #-#, Volume 8.

United States Air Force (Air Force). 1997. Environmental Effects of Self Protection Chaff and Flares. Final Report. August.

_____ . 2001. Final Environmental Assessment for the Defensive Training Initiative, Cannon Air Force Base, New Mexico. Prepared for Air Combat Command, Langley Air Force Base, Virginia.

United States Forest Service. 1992. Report to Congress: Potential Impacts of Aircraft Overflights of National Forest System Wilderness. Prepared pursuant to Public Law 100-91, The National Parks Overflights Act of 1987.

United States General Accounting Office. 1998. DoD Management Issues Related to Chaff: Report to the Honorable Harry Reid, U.S. Senate.

Ward, D.H., R.A. Stehn, W.P. Erickson, and D.V. Derksen. 1999. Response of Fall-Staging Brant and Canada Geese to Aircraft Overflights in Southwestern Alaska. Journal of Wildlife Management 63(1):373-381.

Weisenberger, M.E., P.R. Krausman, M.C. Wallace, and D.W. De Young, and O.E. Maughan. 1996. Effects of Simulated Jet Aircraft Noise on Heart Rate and Behavior of Desert Ungulates. Journal of Wildlife Management 60(1):52-61.

Westman, J.C., and J.R. Walters. 1981. Noise and Stress: a Comprehensive Approach. Environmental Health Perspectives 41:291-309.

White, C.M., and T.L. Thurow. 1985. Reproduction of Ferruginous Hawks Exposed to Controlled Disturbance. Condor 87:14-22.

Workman, G.W., T.D. Bunch, L.S. Neilson, E.M. Rawlings, J.W. Call, R.C. Evans, N.R. Lundberg, W.T. Maughan, and J.E. Braithwaite. 1992. Sonic Boom/Animal Disturbance Studies on Pronghorn Antelope, Rocky Mountain Elk, and Bighorn Sheep. Utah State University. Contract number F42650-87-0349. Submitted to U.S. Air Force, Hill Air Force Base, Utah.

This page intentionally left blank.